Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

NOVEMBER, 1913.

THE ESTABLISHMENT OF A RACE OF WHITE CANARIES.

By MAUD S. MARTIN.

SOME white canaries were exhibited before the Linnean Society, in the year 1912, and the following is an account of how the race was obtained, by Mrs. Martin, who bred them. Professor Arthur Dendy, F.R.S., who introduced the exhibit, has kindly written the following lines by way of preface to the article.

Last year I had the pleasure of meeting Dr. Palmer, of New Zealand, who had brought over to England a considerable number of white canaries bred by Mrs. Martin. At my suggestion Dr. Palmer exhibited a pair of these very beautiful birds at a meeting of the Linnean Society, where they aroused great interest, and in response to a request for further information as to how they had been obtained, Mrs. Martin has very kindly written the following account, which I feel sure will be welcomed by readers of "KNOWLEDGE." "Mendelism" is so much to the front nowadays that it is hardly necessary to point out the great interest of Mrs. Martin's observations. They afford an excellent illustration of the wonderful power which the scientific study of heredity has placed at the disposal of those who wish to produce new and permanent varieties of plants or animals. White canaries have, it is true, occasionally been obtained as sports by previous breeders, but I believe I am right in saying that no one has hitherto succeeded in establishing a pure white breed. That this has now been accomplished by an amateur, working alone in New Zealand, and without any special scientific training, shows how much may be expected in the future from the application of Mendelian principles. Thanks to such writers as Professor Bateson and Professor Punnett—to mention only two of the best known workers in this field—a knowledge of these principles is now widely disseminated, and Mrs. Martin's work illustrates very clearly how easily and successfully such knowledge can be put to practical use.

Mrs. Martin is, of course, responsible not only for the results obtained, but also for the form in which those results are set forth; but in justice to her it should be stated that, being in New Zealand, she has had no opportunity either of consulting with specialists in the subject or of revising the proofs of her paper.

A. D.

During the season of 1908–9, a pure white hen canary (having a grey tick on the left cheek) was hatched in Martinborough, Wellington, New Zealand, being a sport from ordinary buff parents—its mother being a buff hen with a black cap, and its father a buff cock with a green crest and green wing mark. In the same nest as the white sport were three other birds, all buffs, more or less marked with green. All the birds in this aviary were very much in-bred, and many of them were very pale in colour, being a creamy white in the nest feathers, but moulting

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brighter. One very pale cock bird (with a grey tick of the left cheek) was mate to most of the hens both young and old.

The parent birds escaped after rearing their brood.

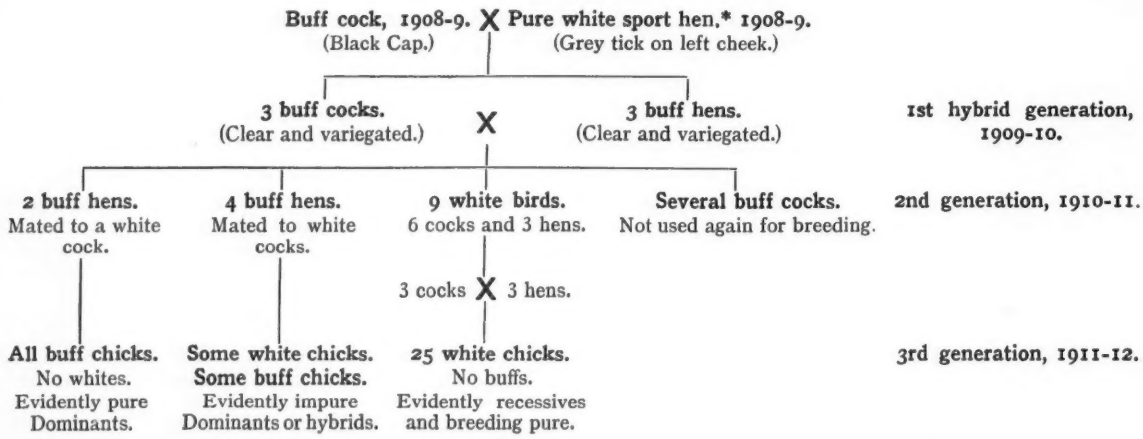
The white sport hen was bred by Miss Lee, of Martinborough, and I purchased it from her, as I intended, if possible, to produce from it a race of white canaries breeding true to colour. To attain this end I determined to experiment on Mendel's lines and bought as a mate for the white sport a buff cock, quite unrelated to her. From the mating of this pair in 1909–10, I reared three buff cocks and three buff hens (see Tables 72 and 73). No "whites" appeared, which is, of course, what I expected. The white sport hen died before the next season, so I was unable to use her again, and was left with her young ones (three buff cocks and three buff hens) to carry on the experiment. Some of them were clear and some variegated.

These three buff cocks and three buff hens I mated together in 1910–11 and obtained from them forty-eight buff chicks and eighteen white ones, proving their hybrid character (see Tables 72 and 74). Nine of the "whites" were reared, six cocks and three hens, and I kept five buff hens to breed with the following year. The buff cocks I did not use for breeding as I had not white hens enough to spare to test them with to see if they carried white blood. Also there would certainly be some dominants in them and I did not want to increase my breeding operations or to multiply the buff birds—for which reason I did not use the buff hybrid cocks of the first generation again, but used only the white cocks as mates for all the hens the following year.

The three buff hens of 1909–10 (first hybrid generation) I mated in 1911–12 to their sons the white cocks of 1910–11 (second generation) and from them I obtained fourteen buff chicks and twenty-six white chicks (see Table 75).

The three white hens (1910–11, second generation) I mated to white cocks (1910–11, second generation) in 1911–12, and from them I obtained twenty-five white chicks, no buff ones appearing in the nests at all, apparently proving their recessive character (see Table 76). The six buff hens (1910–11, second generation, I mated to white cocks (1910–11, second generation) in 1911–12. Two of them gave me only buff birds, no white ones appearing in the nests at all, which looked as though they were dominants, (see Table 77), the other four hens having sixteen buff chicks and twenty-seven white ones, evidently being hybrids, or impure dominants (see Table 78).

TABLE 72.


Buff cock, 1908-9. (Black Cap.)
X
Pure white sport hen.* 1908-9. (Grey tick on left cheek.)
3 buff cocks. (Clear and variegated.)
X
3 buff hens. (Clear and variegated.)
1st hybrid generation, 1909-10.
2 buff hens. Mated to a white cock.
4 buff hens. Mated to white cocks.
9 white birds. 6 cocks and 3 hens.
Several buff cocks. Not used again for breeding.
2nd generation, 1910-11.
3 cocks X 3 hens.
All buff chicks. No whites. Evidently pure Dominants.
Some white chicks. Some buff chicks. Evidently impure Dominants or hybrids.
25 white chicks. No buffs. Evidently recessives and breeding pure.
3rd generation, 1911-12.

* NOTE.—The white sport was bred from ordinary variegated buff parents and very much in-bred. One pale buff cock, in particular, appeared several times as father in previous generations, the white hen being his granddaughter on both sides.

The details of each nest are made out in the accompanying tables. The eggs were carefully numbered and the young had numbered rings on their legs, so that there should be no mistaking the birds belonging to each pair.

The white chickens are easily distinguished directly they are hatched, as their skin is a pale bright pink, quite unlike the ordinary yellow appearance of a common hatching. Very often (but not always) the hybrid chicks have a pinkish-yellowish body when first hatched, but this soon turns yellow, and is never the bright light pink of the white chick. Also the hybrid chicks are generally (but not always) very pale in the nest feathers, quite a creamy white, but becoming brighter yellow later, although many remain very pale, but not all of them. It was on account of these two peculiarities of the hybrid birds that I mated the two buff hens (see Table 79) to the white cocks, as I suspected that they would have

young white ones, which they both did have. Hen I. (1907–8) I hatched in my own aviary, and she was almost white in the nest feathers and always continued very pale, and when mated to a goldfinch gave me pied mules. Hen II. (1909–10) had peculiarly pinkish-yellowish chicks, so I suspected her too of carrying white blood, and in 1910–11 mated her to a first hybrid generation buff cock, from which mating I got only one pale hen. The following year (1911–12) I mated both mother and daughter to a white cock (1910–11, second generation), and got white chicks from both of them. The daughter is the hen in Pair IV. in Table 78.

I have other pale hens (older) related to the white sport (but not descended from her), as Miss Lee and I have for many years exchanged birds from our aviaries. These hens I intend this year to mate with white cocks, to prove if they are hybrids or not, as I fancy some of them carry white blood too. (Miss Lee, I think, must have many birds capable of producing white chicks—as her birds are mostly very pale—but she does not I think care to experiment systematically.)

TABLE 73.

RESULTS OF MATING BUFF COCK, 1908–9, TO WHITE SPORT HEN, 1908–9.

Unrelated.

Pair.	Buff Chicks.	White Chicks.	Remarks.
Original. 4 broods.	2 2 3 2	0 0 0 0	The young ones in the third nest died.
	9 six survived.		1st Hybrid Generation, 1909–10.

TABLE 74.

RESULTS OF MATING 3 BUFF COCKS AND 3 BUFF HENS, 1909–10.

1st Hybrid Generation from Buff Cock and White Hen Sport, the Hens being the Sisters of the Cocks.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 6 broods.	3 3 2 4 3 3	0 1 1 1 1 0	
II. 6 broods.	4 4 1 4 3 3	1 0 1 1 1 2	
III. 7 broods.	1 3 4 1 2 0 0	0 1 0 3 1 1 2	
	48	18	2nd Generation from White Hen, 1910–11.

TABLE 75.

RESULTS OF MATING 3 BUFF HENS, 1909–10, OF THE 1ST HYBRID GENERATION TO 3 WHITE COCKS OF THE 2ND GENERATION, THE HENS BEING THE MOTHERS OF THE COCKS.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 5 broods.	2 1 0 0 2	2 2 3 1 0	
II. 5 broods.	1 0 4 0 1	1 4 2 0 3	
III. 4 broods.	0 0 2 1	3 1 1 3	
	14	26	

TABLE 76.

RESULTS OF MATING 3 WHITE COCKS AND 3 WHITE HENS, 1910–11, 2ND GENERATION FROM WHITE HEN.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 3 broods.	0 0 0	2 4 4	The first hen died half-way through the season. All the birds were white, as was expected and hoped for. It appears that white colouration is recessive according to Mendel's law.
II. 4 broods.	0 0 0 0	0 5 2 0	
III. 4 broods.	0 0 0 0	3 2 0 3	
	0	25	3rd Generation from White Hen.

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TABLE 77.

RESULTS OF MATING 2 BUFF HENS, 1910–11, AND WHITE COCKS, 1910–11, ALL SECOND GENERATION FROM WHITE HEN SPORT.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 4 broods.	3 4 2 3	0 0 0 0	Apparently these two hens were dominants, as they gave no white chicks in any nest.
II. 3 broods.	3 3 4	0 0 0	
	22	0	3rd Generation, 1911–12.

TABLE 78.

RESULTS OF MATING 4 BUFF HENS, 1910–11, AND WHITE COCKS, 1910–11, ALL SECOND GENERATION FROM WHITE HEN SPORT EXCEPT THE HEN IN PAIR IV.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 3 broods.	0 3 2	3 2 2	Apparently these 4 hens were impure dominants, as they gave white chicks as well as buffs. The hen of the 4th pair was descended from the White Sport Hen on the father's side only, though related on the mother's.
II. 3 broods.	3 1 1	0 3 1	
III. 3 broods.	1 2 1	3 2 2	
IV. 3 broods.	0 1 1	4 2 3	
	16	27	3rd Generation, 1911–12.

TABLE 79.

RESULTS OF MATING 2 BUFF HENS (CLOSELY RELATED TO THE WHITE SPORT, ONE BEING ONE YEAR OLDER AND ONE BEING ONE YEAR YOUNGER, BUT NOT DIRECTLY DESCENDED FROM HER, BOTH HAVING ANCESTORS IN COMMON AND BOTH BEING DESCENDED FROM THE PALE BUFF COCK MENTIONED IN THE NOTE (TABLE 72), TO WHITE COCKS, 1910–11.

Pair.	Buff Chicks.	White Chicks.	Remarks.
I. 2 broods.	0 0	1 1	Other nests of the hen in Pair I came to nothing. The hen in Pair II was the mother by a buff cock (1st Hybrid Generation) of the hen in Pair IV. in Table 78.
II. 3 broods.	3 1 3	2 1 1	
	7	6	

NOTE.—I mated these two buff hens to white cocks as I knew they were both related to the White Sport, and I thought, for several reasons, that they might carry white blood. Evidently, the white blood must have been in the strain several years before the White Sport was hatched. No more whites have appeared in that aviary, but they have not tried for them systematically. I have other old hens related to the White Sport, which I am mating this year to White Cocks, to see if perhaps they will prove to be hybrid from their breeding results.

TABLE 80.

RESULTS OF MATING JONQUE CINNAMON HEN AND WHITE COCK.

Unrelated.

Pair.	Description of young birds.	
I. 3 broods.	1 jonque green hen. 1 buff green cock. 1 clear buff hen.	No whites appeared, as was expected. The buffs are exceptionally pale coloured.
	1 buff green hen. 2 clear buff cocks. 1 yellow bird (died young).	
	3 green birds. 2 yellow birds (died young).	

All my birds (and also Miss Lee's) are buff, being bred from buff cocks and buff hens, except the progeny from the jonque cinnamon hen (see Table 80) from which bird I have one jonque green hen, to be mated this year (with the other young of the cinnamon hen) with a white cock. This cinnamon I bought, and it is quite unrelated to my other stock. The clear buff hen in the cinnamon's first nest was extremely pale (quite white in patches) in its nest feathers, and has remained extremely pale, as have also the two young clear buff cocks in her second nest; they are quite as pale as any of my buff birds bred from clear buff hens and white cocks, and much paler than many of them. This is remarkable as the basis of cinnamon colouring is green.

All my white birds have black eyes, not pink as one might imagine they would have, and they are very strong and hardy, being bred and reared out of doors and living in an open out-door aviary all the year round.

In their case their white plumage does not seem to make them delicate.

Altogether I think the experiment has been most successful, as I have established my race of white canaries breeding true to colour, and apparently the colours yellow and white obey the Mendelian laws, producing dominants, impure dominants (or hybrids) and recessives.

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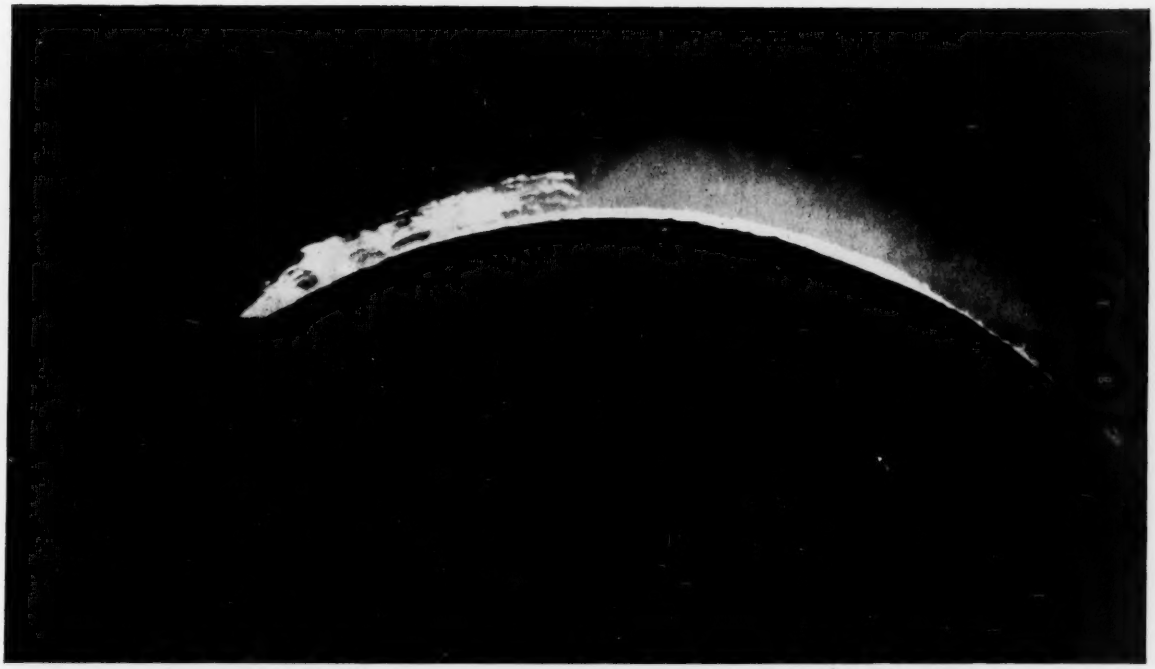
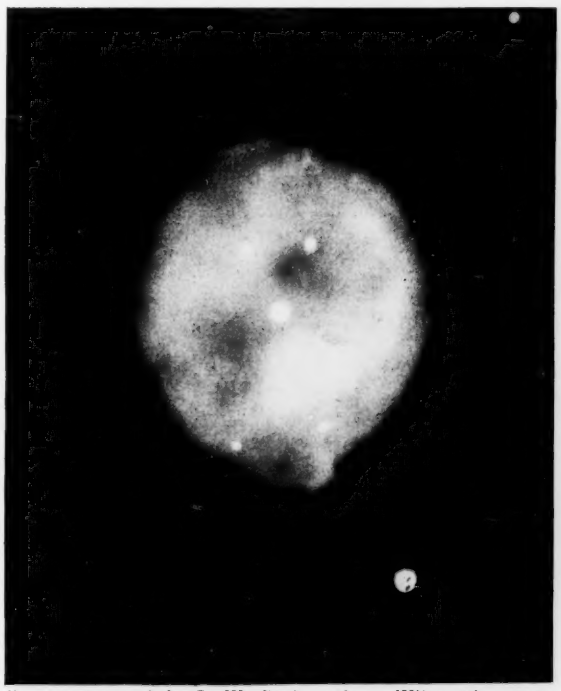


From a photograph by De la Baume Pluvinel* *Alcala de Chisvert, Spain, August 30th, 1905.*

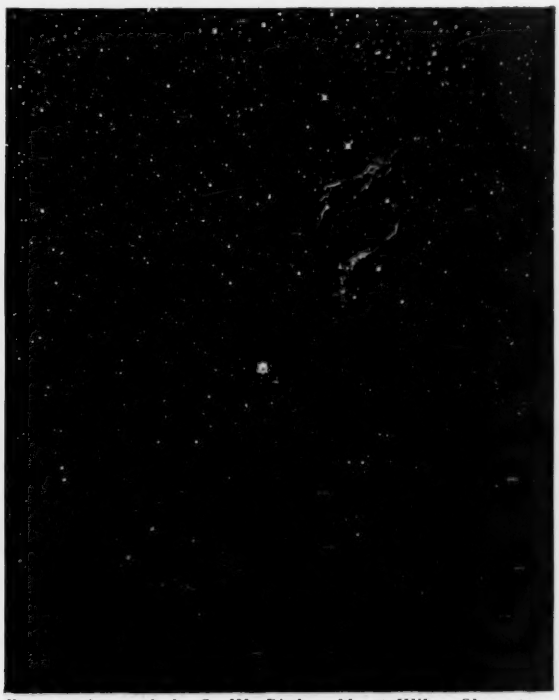
FIGURE 419. Prominences that can be seen by means of an ordinary telescope only during an eclipse, but which are shown at all times when a telescope is armed with prisms of wide dispersion.

* Horizontal Refractor and Coelostat. *Ap.* 0.153m. (6″). *F.L.* 11.880m. (38′ 11¾″.) *Exp.* 2 secs.



From a photograph by G. W. Ritchey, Mount Wilson Observatory, February 9th, 1910.

FIGURE 420. Owl Nebula in Ursa Major (N.G.C. 3587) showing the central star, the bilateral symmetry, and the concentric appearance that would occasionally be a late stage in the third body produced by a graze of suns.



From a photograph by G. W. Ritchey, Mount Wilson Observatory, July 2nd-4th, 1910.

FIGURE 421. The Nebula in Cygnus (N.G.C. 6992), showing details brought out by the camera which are too faint directly to affect the human eye.

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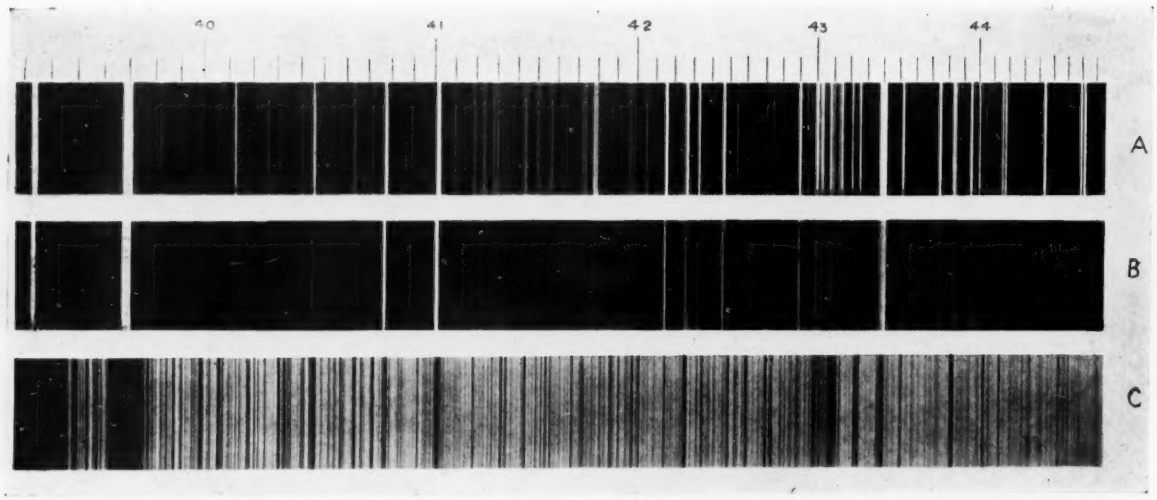
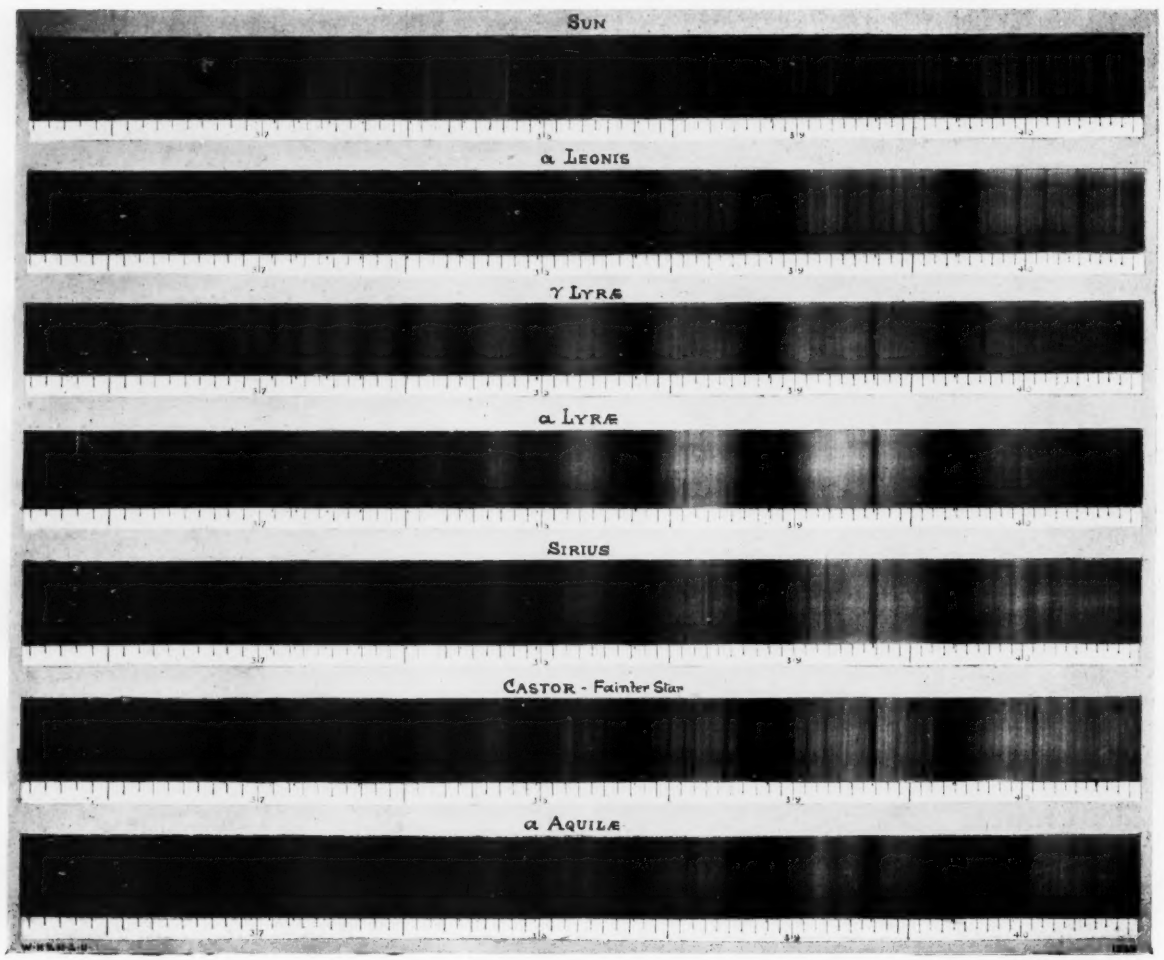


From spectrograms taken with a 2-prism flint spectroscope *by E. H. Hills, Pulgaon, India, January 22nd, 1898.*

FIGURE 422. A* and B†, spectra showing the flame bands of the reversing layer of the Sun seen during an eclipse. C, the dark lines of the ordinary spectrum when the Sun shines through glowing metallic vapours.

* At point of second contact. † At point of third contact.



From spectrograms by *William Huggins, Tulse Hill.*

FIGURE 423. Spectra of pre-solar stars (compared with the Sun) showing the many dark bands of hydrogen, all of which become bright bands at a certain stage in the life-history of novae.

STELLAR SPECTROSCOPY FOR BEGINNERS.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

I. INTRODUCTORY HISTORIC SKETCH.

THE arming of the telescope with the prism and photographic plate has produced another bound forward in astronomical discoveries as great as that made three hundred years ago, when Galileo armed the eye with his wonderful optic tube. The telescope extended our knowledge into such abysses of space that the millions of miles to the distant Sun became almost too short a unit with which to measure them. It showed us that the filmy light of the Galaxy was a seed-bed of millions of suns, as Democritus so clearly described it two thousand years before. Some of these suns proved to be so vast as altogether to dwarf our majestic orb. The telescope showed us also that the distant inhabitants of space possess as great a diversity of structure as immensity of mass.

The cipher messages unfolded by the prism were to reveal the most unexpected truths: these rainbow-tinted strips of light we call spectra, told us, not merely the structure, but also the chemical composition of the many members of those distant regions.

The year 1642, when Galileo died, was that in which Newton was born. Amid his many wondrous discoveries of appliance and of principle it had been the especial privilege of Galileo to apply the telescope to the reaping of a rich and varied celestial harvest. Newton continued to garner this wonderful harvest, but he also sowed the seed of another crop of results scarcely to be begun to be reaped before two and a half centuries had elapsed. This fertile experiment of Newton's was to place a prism of glass in a beam of sunlight that streamed through a hole in the shutters of a window; thus he analysed and decomposed the light into its constituents. It was a wonderful but crude experiment, for the lovely strip of light he so produced was what we call an impure spectrum. Newton never much improved on his beautiful basic experiment; it did not occur to him to use a narrow slit instead of a round hole, to prevent his colours from overlapping, and so render his tints pure. It was reserved for Wollaston and Fraunhofer to do that, and so discover that the spectrum of the Sun (as Newton called the coloured strip of light) was broken up by black bands. Wollaston saw these bands, but thought too little of them to take much trouble to perfect his experiments. Not so Fraunhofer: he carefully plotted them, and named them with the letters of the alphabet to distinguish them, and so we still call these revealing ciphers Fraunhofer lines. By-and-by it was found that the light of burning metals gave coloured lines instead of a rainbow-tinted strip, and soon, in the hands of Bunsen and Kirchhoff, this furnished a means of detecting the chemical elements: an instrument was constructed to do this which was called the spectroscope, and spectrum analysis was born.

SPECTRUM ANALYSIS.

It had long been known that the colour of these flames was characteristic of many elements, and these varied colours were used to give beauty to fireworks and as aids in chemical analysis. If we examine a set piece in a pyrotechnic display with a spectroscope, the instrument spreads each colour out into a series of separate lines of light. The yellow in a firework display is caused by sodium, and this element gives a brilliant yellow band. If an exceedingly narrow slit be used in a good spectroscope, the band separates into two parts, and if the light be passed through several prisms, the two constituents may be obtained at quite a distance from one another. Kirchhoff noticed that the exact position of these two bright yellow sodium bands was occupied by two black bands in the spectrum of sunlight. He afterwards discovered that the characteristic bright line of other glowing metals corresponded with other sets of black lines in the solar spectrum. Further experiments showed that the bright bands given by a soda flame became reversed when the electric light was allowed to shine through it. The continuous spectrum produced by the electric arc was crossed with black lines when it shone through the yellow flame. The whole mystery of the Fraunhofer lines was cleared up, the sun was a blazing ball of fire shining through an atmosphere of flaming metals; hence we had the basic discovery that in the radiant beams coming from the Sun we were able to read its composition and character (see Figure 422). With added refinements, the same method was applied to the suns that shine at night; the songs of the singing atoms were read, and told us the story of the stars. A great principle had been revealed to man: the same elements that have been used to build this Earth go to make up the structure of the heavens. Gradually, as revelation after revelation has come to us, we realise that "all are but parts of one stupendous whole," that Nature is a

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complex unity; and the latest revelation of all that the stars are telling us in the cipher messages is that the scheme of creation is a cyclic system infinite and immortal.

THE PHYSICS OF THE STARS.

The principle of isochromatic reversal was not merely to tell the chemistry of the heavens, but, joined to another fact called Doppler's principle, was to unfold all kinds of physical facts and astronomic wonders.

DOPPLER'S PRINCIPLE.

The express that took me to the British Association Meeting at Birmingham passed another express that had its steam whistle in full blast. As the train approached the note was ghastly in the high pitch of its shriek; suddenly, as the engine passed, the note dropped enormously, to be followed instantly by a low-pitched groan. I had often noticed the pitch of an insect's hum drop as it passed me, and, standing on a railway bridge, had heard the note of a steam whistle change as it passed under the bridge. But the passing of those two swift expresses gave me an illustration of Doppler's principle that I have never heard equalled before.

Each vibration produced by the approaching whistle was made in a position nearer to us than the former impulse, so they were closed up and became shorter; a shorter wave produces a higher pitch, and so the whistle shrieked; when the train had passed, and was going away, each vibration originated at a more distant point and the waves were lengthened, the note consequently dropped, and the high shriek became a low groan.

The same principle applies to colour: the slow waves of light are red, the swift ones violet, the other tints have intermediate velocities. Suns, when very close to one another, have been pulled by mutual gravitation, so that they may have speeds of hundreds of miles a second; the pitch of the definite waves produced by each kind of their singing atoms have the pitch of their definite waves of light altered, and they become shorter as the suns approach, and longer as they recede.

Hence a pair of suns that in our most powerful telescopes appear to be a single point of light may, under the spectroscope, give us a spectrum in which a characteristic line of hydrogen may appear double, and each line be displaced from the normal position. In such a double star the sun approaching us will give us lines displaced towards the violet, and the sun receding a line displaced towards the red end of the spectrum. Thus the spectroscope reveals the motion as well as the composition of heavenly bodies.

If the pair of suns graze, a third body is struck off, like the spark from flint and steel. In the case of the exploding third star, produced in this way by grazing suns, the quickly expanding and ensphering shell of hydrogen that would be produced, as described in "KNOWLEDGE" in September 1911, would be made up of atoms moving in all directions away from the nucleus of the exploding sun, and hence in all directions to our line of sight (see Figure 420). The atoms moving towards us would give lines displaced towards the violet, and those away from us towards the red. Intermediate directions would have resolved velocities that would fill the space between these. The single line of light that would be produced were the hydrogen at rest, would broaden into blaze bands, occasionally showing an opposite speed on the two edges of each band of thousands of miles a second. In the special case of Nova Persei, the displacement in each direction was fully a thousand miles a second. This is perhaps the most interesting historic example of the physical reading of stellar spectroscopy. The details of these two wonderful principles of reversal of light and change of speed will be given in detail in the succeeding articles. Figure 423 shows the dark bands of hydrogen as seen in ordinary stars.

THE ASTRONOMY OF THE INVISIBLE.

This principle of relative motion of lines reveals the existence of dead suns by their influence on luminous stars; the spectra of some stars are seen to have their bands moving periodically backwards and forwards on the spectrum. Such a pair of stars are one class of what are known as spectroscopic binaries, so called because it is only in the spectroscope that the fact that they are double stars is revealed. Because in addition, as in the case of Algol the Demon Star, the dark star sometimes eclipses the bright one, we are able to deduce their orbits, and thus weigh and measure these two properties of the two constituents.

SOLAR ECLIPSES.

When the Moon exactly covers the face of the Sun, as it did for a second or so last year, if we arm the telescope with a prism, a series of images of the circular rim of light is produced. There is a different ring for each special note of the vibratory atoms of the various metals. We thus get a most singular spectrum covered with rings of light, instead of straight lines; some of the rings overlap one another and some stand clear. Probably it is not more than once in a century that the disc of the Moon and the Sun thus exactly overlap and leave the reversing layer to be seen all round. There is only one small spot on all the Earth (and that not precisely known) where it can be seen. Its duration is something like a second. Yet the photograph of this rare and elusive phenomenon was actually taken last year in Portugal by James H. Worthington. It will be published in the next number of "KNOWLEDGE." The same principle is used during ordinary eclipses to photograph the great crimson hydrogen flames and the metallic outbursts that spring from the Sun (see Figure 419).

By means of the same method of placing a large prism in the path of the rays gathered by the telescope it is possible to so dilute the ordinary

white solar light that the monochromatic light of the hydrogen flame may be seen when there is no eclipse. By making an extremely long spectrum the ordinary sunlight is so spread out as to be insignificant, whilst the red monochromatic light of the flames retains its intensity, and thus we are enabled to see these red flames during ordinary sunlight.

THE PHOTOGRAPHIC FILM.

Another principle adds greatly both to the power of the ordinary telescope and particularly when the optic tube is armed with a prism. It is the application of photography to astronomy. One wonderful effect is obtained by photography; the human eye soon tires, whereas the photographic film will continue to add to its effects for hours or even days, and thus filmy masses of light that would for ever have remained undetected imprint their message on the sensitive plate until, as in the case of the nebulae of the Pleiades, details of structure are shown connecting up the whole of this beautiful cluster of stars, yet with the ordinary telescope, used by the naked eye, the stars seem to stand out on an almost absolutely dark background. An example still more remarkable of the minuteness of its detail is given in Figure 421. Another effect of photography is that the film may be left exposed, or exposed automatically, so as to record effects when no one is near. Perhaps the most wonderful of all the applications of photo-spectroscopy is the work done in Harvard Observatory and its branches, of the wholesale automatic photography of the spectrograms of large numbers of stars, taken all at once.

THE IMPORTANCE OF THEORY.

Years ago Newcomb feared that the science of astronomy would be buried beneath the tremendous mass of uncorrelated facts that were then accumulated; yet in spite of this the whole endeavour of astronomy, until quite recently, has been merely further accumulations. This state of things is passing; endeavours to correlate astronomical phenomena are being made by able men, both in the New World and the Old. And although these endeavours have not hitherto been eminently successful, nor much accepted save by their respective propounders, yet the attempts are promising symptoms of the times. There is a distinct advance on the part of astronomers in their willingness to receive the assistance of workers in other branches of science. Physicists and chemists are allowed to read papers before astronomical societies. On the other hand the learned societies representing experimental science now make room for cosmic generalisations. At the British Association Meeting joint conferences of many sections were held.

All this is very hopeful, for nothing causes science to spring forward by such leaps and bounds as great generalisations. Although they are thus the milestones in human progress, generalisations have generally been neglected for something like half a century. We are not without examples of disastrous neglect in the present age of science. The broadening outlook gives us at present a better prospect and supplies a probability that research will be no longer mere vicious specialisation, but each expert will do his work with definite purpose and in correlation with the sum of knowledge.

Amid all the tremendous rush of present discovery there is no branch of knowledge that is correlated so widely in all directions as spectroscopy, and no scientific worker should be ignorant of its basic principles.

CORRESPONDENCE.

RAY FLORETS IN THE DISC OF *CHRYSANTHEMUM*.

To the Editors of "KNOWLEDGE."

SIRS,—I enclose you a photograph of a specimen of the common Marguerite (see Figure 505, page 431) in which two strap florets have been produced in the centre of the group of tubular ones; the two strap florets were surrounded at their bases by a small involucre. I have not seen a flower like this before, and thought the reproduction of the photograph might be of interest to readers of "KNOWLEDGE."

NEWCASTLE-ON-TYNE. JOHN HUME.

AUSTRALITES.

To the Editors of "KNOWLEDGE."

SIRS,—The short account given by Mr. G. W. Tyrrell (page 308) on the subject of "Australites" (which formed the subject of a memoir by Mr. E. J. Dunn, of Victoria, Australia) has interested me very much.

In the year 1909 it fell to my lot to make a journey from the coast of Vera Cruz up to near Mexico City on horseback, accompanied by another geologist. The trip took four days, and we rose close on seven thousand feet.

On the second day out, my companion who had done the same journey previously, said to me, "To-morrow we shall pass beds of sand and sheets of basalt, and I want you to give me your unbiased opinion about the relative geological positions of the sands and basalt, *i.e.*, whether the sands lie above the basalts or *vice versa*."

The third day brought us to the sands, and on seeing a pure white silvery sand I at once said, "Why, that is not sand, it is volcanic ash," and you can imagine my astonishment when, on examining the sand with my pocket lens, I found that a large percentage of the grains consisted of perfect little bubbles.

No doubt the greater part of the remaining grains would be "Australites," but this I did not know at the time.

I think that the conditions in Mexico prove conclusively volcanic origin, for amongst the sand were later on discovered pieces of fibrous pumice and a large amount of dark green obsidian.

The obsidian, by the way, gave the source from which the supply was obtained to make the numerous arrow-heads and long flat needle-shaped spears frequently picked up in the coastal regions.

I hope that the above will prove of interest to your readers.

F. W. MOON (A.M.I.C.E., F.G.S.).

TANDJONG POERA, SUMATRA.

XUM

THE STORY OF THE CHIN.

By LOUIS ROBINSON, M.D.

THE human lower jawbone differs in a very essential manner from those found among the rest of the Primates—and all other vertebrates—in having its lower anterior border bent downwards and forwards so as to form a chin. Recent discoveries of the remains of early men, such as the Heidelberg and Piltdown jaws, have informed us that this distinctive shape of the inferior maxilla has increased in a marked degree since the lower stages of man's existence (see Figures 500 to 504).

FIGURE 424. *Amphitherium oweni* (Stonesfield State).

FIGURE 425. Dromatherium (Upper Trias, N. Carolina).

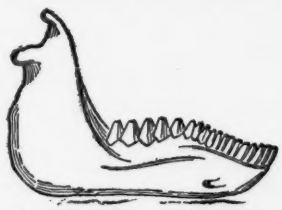


FIGURE 426.—Arsinotherium (Eocene).

I propose to discuss in the present article some of the causes which appear to be responsible for this curious deviation from type. That these causes were evolutionary factors of considerable potency becomes fairly evident when we examine further into the facts. The general type of the mandible among terrestrial vertebrates has been curiously uniform from the very earliest times, as may be seen in the illustrations of mesozoic and eocene jaws (see Figures 424 to 426). It is, we may say, fixed or stereotyped to a remarkable degree. This makes the search for evolutionary forces which have so changed it in our own species all the more interesting.

FIGURE 427. Pariasaurus.

FIGURE 428. Inostransevia.

The elephant (see Figure 431) has a kind of chin, and among older writers in the pre-evolutionary days this fact was adduced as showing its superiority to other quadrupeds. But we now know that the elephant's chin is a mere degenerate remnant of the long lower jaw of his ancestors, the tetrabelodon (see Figure 429) and the mastodon (see Figure 430). In the illustrations to which reference is made the process of its downward evolution is plainly shown.

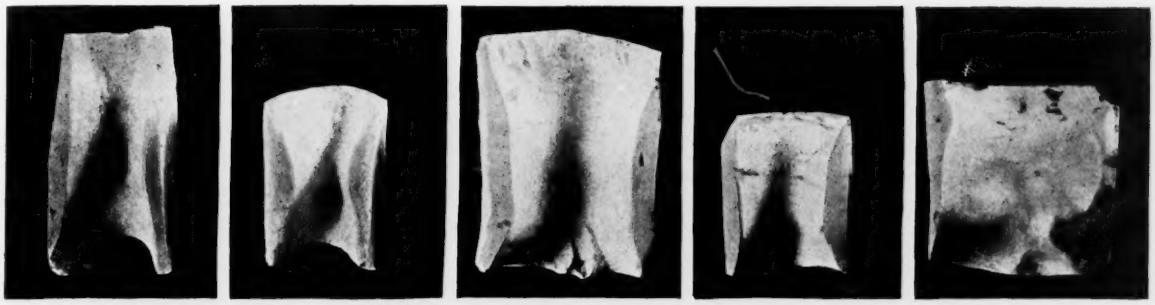
Another interesting example is found in the dugong and its relations (see Figures 482 to 484). Here a little search into palaeontology shows that this apparent chin is not, like the elephant's, a relic of decayed functions, but that it has, like that of man, increased and improved with the ages. As seen in the illustrations the dugong's collateral ancestor, the halitherium, and its big extinct relative, known as Steller's sea-cow (*Rhytina gigas*), had "chins" also, but in a less marked form. As a matter of fact the downward prolongation of the mandible in these animals is not a chin comparable with our own at all, but is merely a kind of bony rostrum on which the dugong and its relations wear their horny false teeth. This structure, with its curious change of angle, is more comparable to the bony support of the flamingo's bill than to a human chin. A very curious fact is that we appear to find the nearest resemblance in the whole animal world, whether

FIGURE 429. Tetrabelodon.

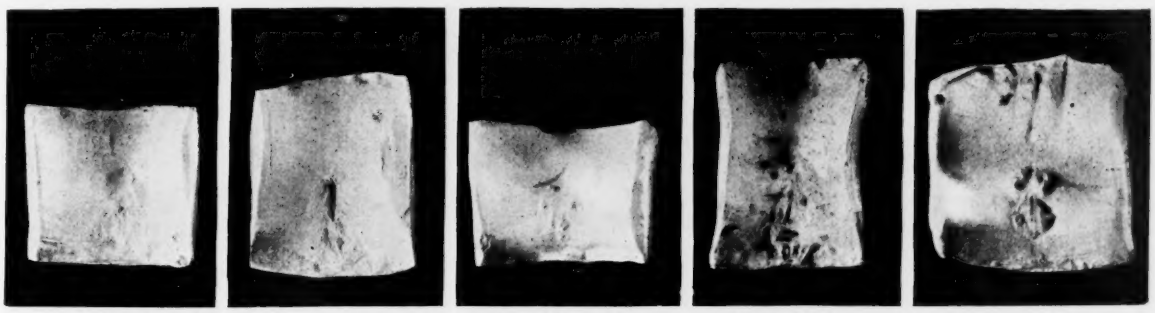
FIGURE 430. Mastodon.

FIGURE 431. *Elephas primigenius.*

There are certain apparent chins found among other vertebrates, a few typical instances of which, with their probable evolutionary causes, it may be interesting to discuss briefly.

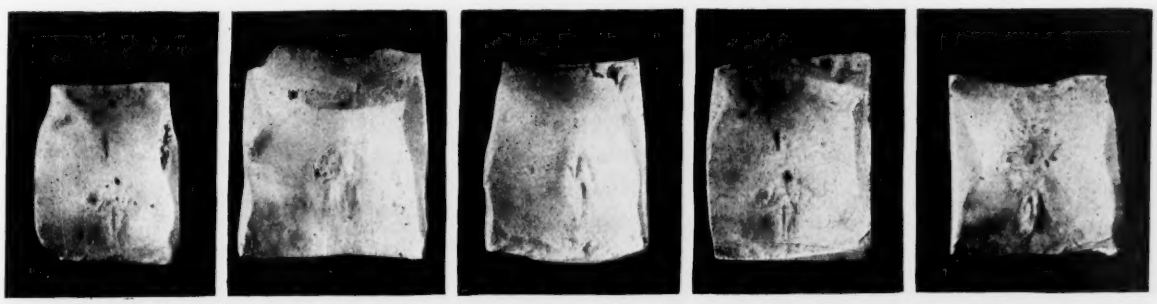


432. Fossil Lemur. 433. Macaque monkey. 434. Chimpanzee (young male.) 435. Siamang gibbon. 436. The Naulette jaw (Spy type.)

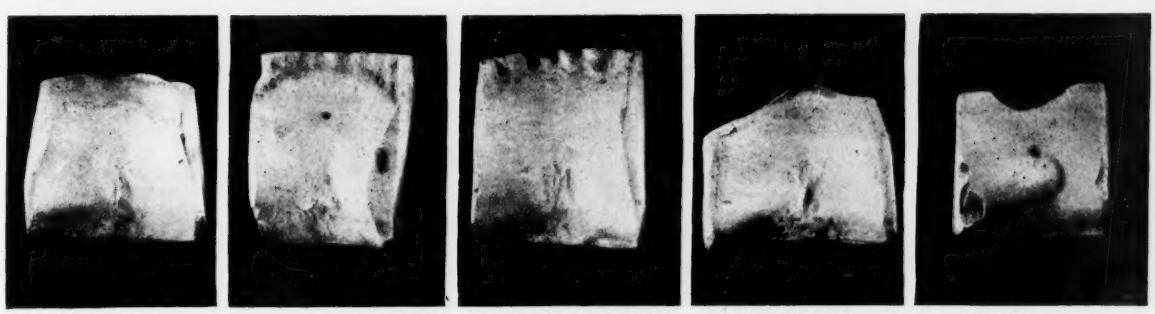


437. Akka Pigmy, from Central Africa. 438. Bushman. 439. Hottentot. 440. Deaf Mute (French). 441. An ordinary European type.

FIGURES 432–441 show the progressive stages from the beginning of the Genial Pit in the Lemur to the fully developed Genial Tubercles in modern civilised man.



442. Hottentot. 443. Hottentot. 444. Bushman. 445. Hottentot. 446. Bushman.



447. Hottentot. 448. Bushman. 449. Andaman Islander (Negrito). 450. Veddah (Ceylon). 451. Low type (West Africa.)

FIGURES 442–451 show the imperfect development of Genial Tubercle and the persistence of the "Simian Pit" among certain low races with only imperfect articulate speech.

CASTS OF THE INSIDES OF LOWER JAWS.

XUM

452. Bushman with tubercles.

453. European Child (six years old).

454. European Child (fourteen years old).

455. European Child (sixteen years old).

456. Ancient Egyptian.

FIGURES 452–456 show the development of the tubercles in young Europeans compared with those well developed in savage and civilised people.

457. Fuegian.

458. Aino.

459. Bushman.

460. Hottentot.

461. Bengali.

462. Tasmanian.

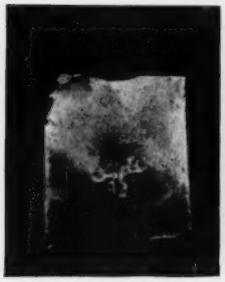
463. Australian.

FIGURES 457–463 afford a study of the remarkable variety of the tubercles in different races.

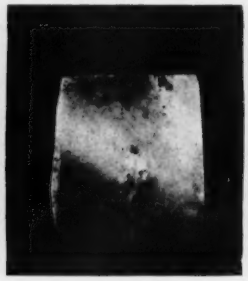
464. The prehistoric Heidelberg jaw.

465. O'Brien, the Irish giant.

FIGURES 464–466 show the contrast between the prehistoric type and the well-developed modern type.



466. Maori.



467. Japanese.

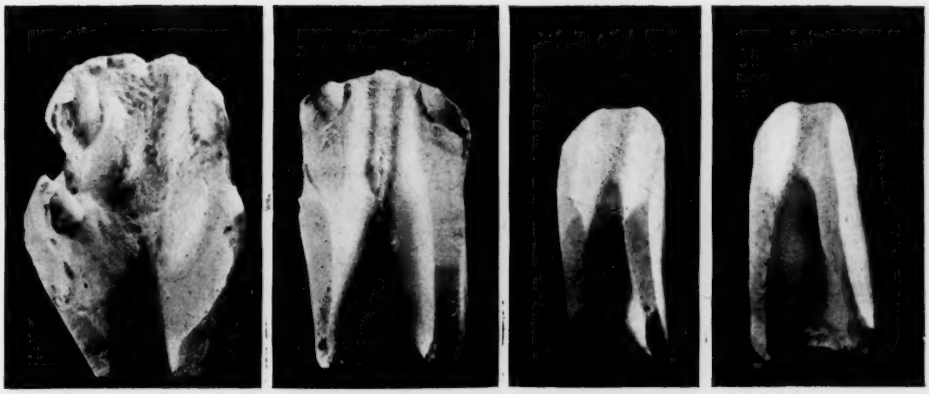
468. Tartar.

469. Malay.

470. Chinese.

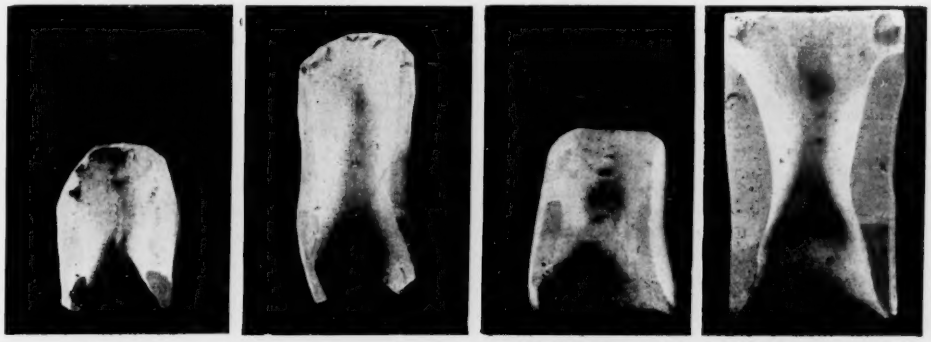
FIGURES 467–470 show the general similarity in races that are somewhat akin in blood and language.

CASTS OF THE INSIDES OF LOWER JAWS.



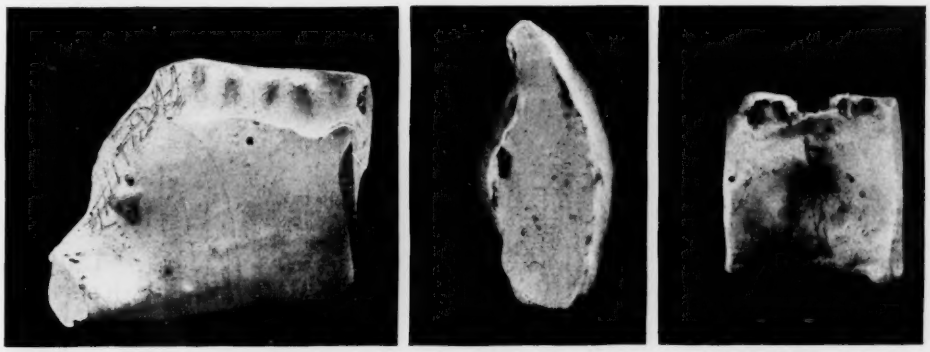
471. Wolf. 472. Leopard. 473. Chacma Baboon. 474. Anubis Baboon.

FIGURES 471–474 show the marked contrast on the inner side of the jaw between the dog-like apes and the Canidae and Felidae.



475. Lemur. 476. Howler Monkey. 477. Proboscis Monkey. 478. Chimpanzee with exceptional pit.

FIGURES 475–478 form an extremely heterogeneous group.



479. The Piltdown jaw. 480. Profile section of the Heidelberg jaw. 481. Central African Pigmy.

FIGURES 479–481 show prehistoric jaws compared with a low type of modern savage.

CASTS OF THE INSIDES OF LOWER JAWS.

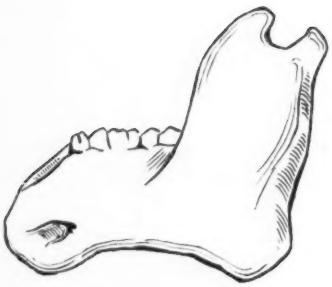


FIGURE 482. Halitherium.

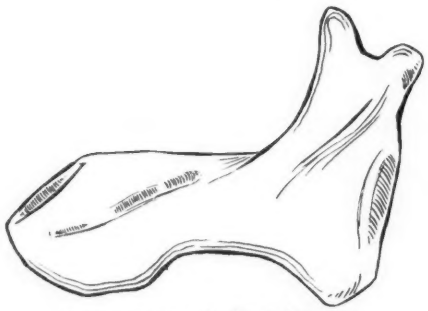


FIGURE 483. Steller's Sea Cow.

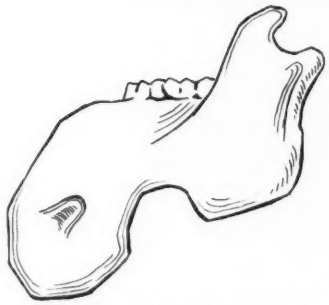


FIGURE 484. Dugong.

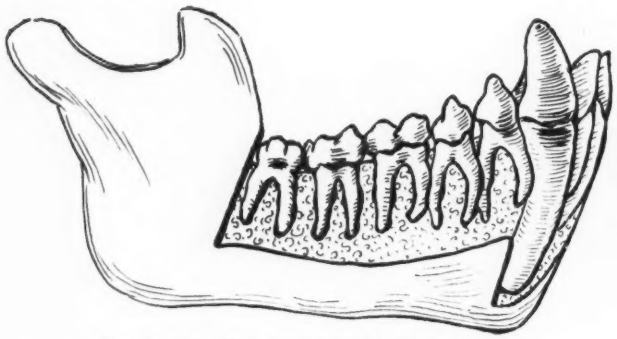


FIGURE 485. The Jawbone of a Chimpanzee,
showing roots of teeth and the stout buttressed socket of the canine filling the side of the "Chin."

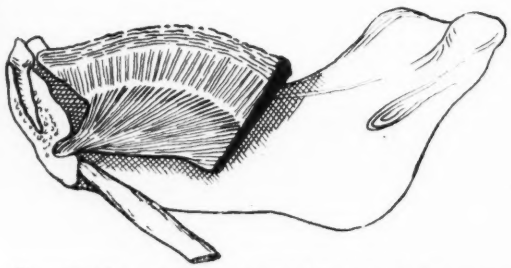


FIGURE 486. The lower Jaw and Tongue of a Macaque,
from a drawing of a dissection by the Author, showing the deep pit for the origin of the *genio-glossus* muscle.

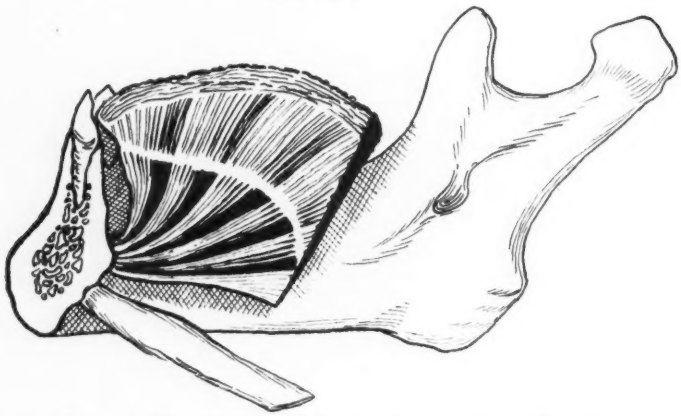


FIGURE 487. Human Jawbone with part of the Tongue,
drawing showing the spreading *fasciculi* of the *genio-glossus* muscle, and their origin from the upper genial tubercle.

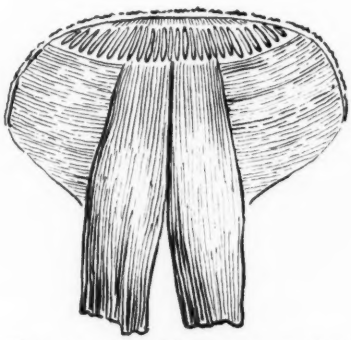
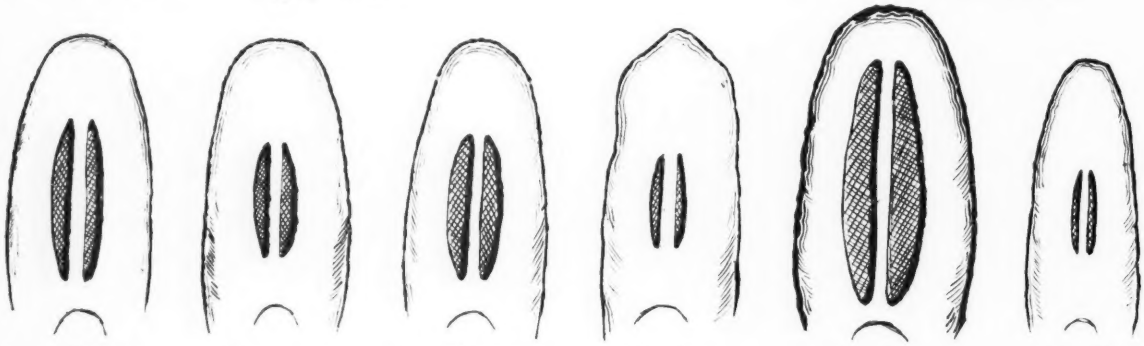


FIGURE 488. Transverse section through the Tongue,
diagram showing *genio-glossus* muscle penetrating the intrinsic muscles. After Quain.



489. Siamang. 490. Orang. 491. Chimpanzee. 492. Dog. 493. Man. 494. Pig.

FIGURES 489 to 494 show the under surface of the tongue and the proportions of the *genio-glossus* muscle.

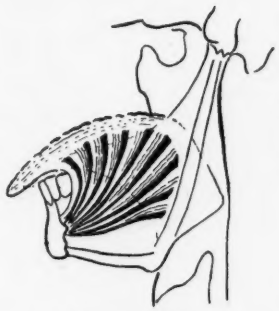


FIGURE 495.
Diagram of the *genio-glossus* muscle at rest.

ancient or modern, to our own mandible in a group of some of the earliest reptiles that have yet been discovered. In the Figures 427 and 428 of those strange thero-

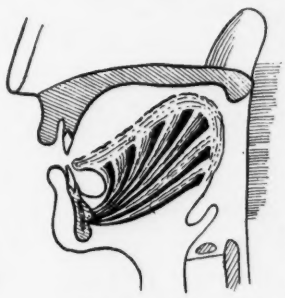


FIGURE 496.
Diagram of the *genio-glossus* muscle in pronouncing the sound "Oo."

morphs, Pariasaurus and Inostransevia, unearthed by Professor Amalitzky in the Permian strata on the shores of the northern Dwina, we see an extraordinary chin which resembles our own in several striking anatomical particulars.

How such a resemblance comes to exist I do not even venture to guess; but most assuredly Nature's moulding forces, which so shaped the mandibles of these ancient reptiles, were totally different from those cerebral activities largely responsible for the chin of civilised man. We say so more confidently because casts of their skull-cavities show that they had no brains to speak of, the whole cerebral chamber being of about the same calibre as the tunnel for the spinal marrow.

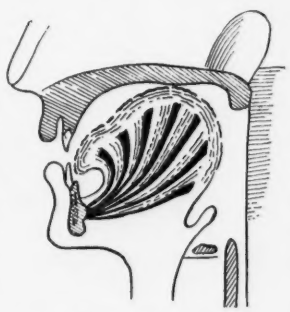


FIGURE 497.
Diagram of the *genio-glossus* muscle in pronouncing the letter "K."

When the writer discussed this subject before the British Association at Birmingham, and there suggested that the needs of the mechanism for articulate speech would probably account for the essential changes in man's lower jaw, it was pointed out by Professor Elliot Smith that man's face differs from those of his nearest congeners in many other particulars quite as remarkable as these. I hope some day to show that most of these other changes have been profoundly influenced, if not actually caused, by structural necessities demanded by articulate speech. To attempt to do so now would take me beyond the scope of the present subject, and I shall therefore confine my attention merely to the changes that have taken place in the mandible.

In the many endeavours that have been made to explain the why and wherefore of the chin, the argument as to its being due to sexual selection deserves most notice. It has been rightly said that the chin is essential to the beauty of the human countenance, and therefore in a choice of mates, those deficient in this direction would be losers in life's race. Arguments from aesthetics are very difficult to handle, because of the extraordinary differences in the standards of beauty, not only among different species of the lower animals, but among different nearly related races of men. Who can doubt that among the anthropoid apes there is a type of apish beauty (including the retreating lower jaw) which satisfies the most critical and exacting simian taste in choosing a mate? We need not do more than allude to the peculiar aesthetic standards obviously existing a little lower down the scale among the baboons, drills, and mandrils.

A chin is now unquestionably a *sine qua non* of human beauty. But how did it become so? When did the simian ideal cease to flutter the hearts of our primitive ancestors?

Do we not find that almost all the adorable features which have this disturbing and fateful influence nowadays are based upon and are the sign of some intrinsic quality contributing to racial efficiency which lies behind mere appearance? The lower races are continually, to the great embarrassment of sundry Colonial Governments, desirous of mating with a superior race differing from them in physique and in colour. There can be no question that if the colonists in such cases were not the superior race this evidence of the working of sexual selection would not appear. It would seem, therefore, that the primitive man who was *manly* and, amongst other manly attributes, had a chin, scored all along the evolutionary line in mating contests over the primitive man who was apelike. The individual or the race which does not recognise the upward stream of tendency in such particulars by instinct alone cannot be found upon the surface of this planet.

One argument against the sufficiency of sexual selection in producing a chin, is the well-known fact that man in the early stages of his existence muffled up his

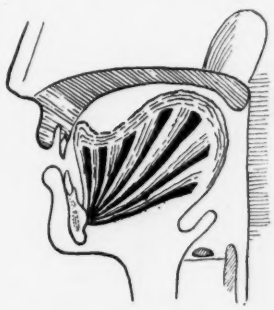


FIGURE 498.
Diagram of the *genio-glossus* muscle in pronouncing the letter "T."

lower jaw with a beard, which is, almost without doubt, of purely ornamental value. Hence it would seem that the

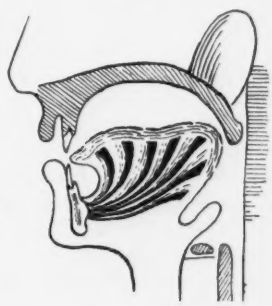


FIGURE 499.
Diagram of the *genio-glossus* muscle in pronouncing the sound "Ah."

XUM

chin *per se* as a sexual ornament was a failure. Women, it is true, have not adopted this form of hirsute decoration; but I doubt if this goes far in helping the aesthetic argument, since, according to the ideals generally current, a big jaw and formidable chin are nowhere considered an excellent thing in woman. I think we shall find that before aesthetics came greatly into play, more prosaic evolutionary forces had already exerted pressure upon the lower jawbone, and had begun to mould it into the general shape in which we find it now.

A glance at the drawing of the mandible of a chimpanzee (see Figure 485) with the roots of the teeth exposed shows the real status of the chin in the anthropoids. It is mainly formed by two thick bony buttresses supporting the sockets of the lower canine teeth. This apparently was the real physical beginning of the bony chin, or rather was, as it were, the gross concrete foundation upon which evolutionary forces of another kind have based the modern structure.

It is a most remarkable and suggestive fact that after man (or the *infra-man*) had lost his huge lower canines, this abundance of bony tissue in the lower edge of the mandible did not disappear, but became more marked as an anatomical feature (see Figure 487). From analogy with the elephant, such a degeneration should have taken place at once. That this did not happen is a proof that the part more than justified its continued existence by performing some function of vital importance to the species.

Sir E. Ray Lankester, in one of his delightful scientific *causeries*, has pointed out that man's chin consists of something more than a bony prominence on the jaw. There is a distinct fleshy pad upon its outer surface, which materially influences its outline and which consists of fatty tissue bound

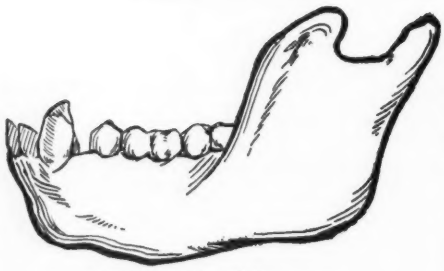


FIGURE 500. Chimpanzee.

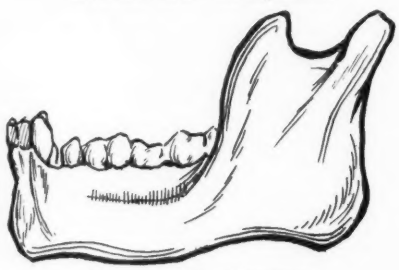


FIGURE 501. Siamang.

FIGURE 502. Heidelberg.

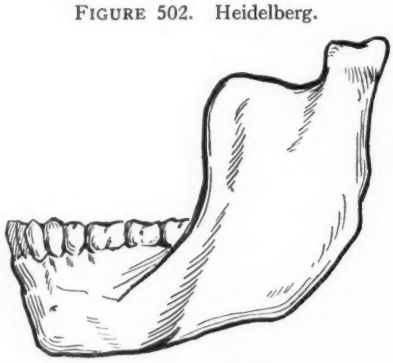


FIGURE 503. Neander type.

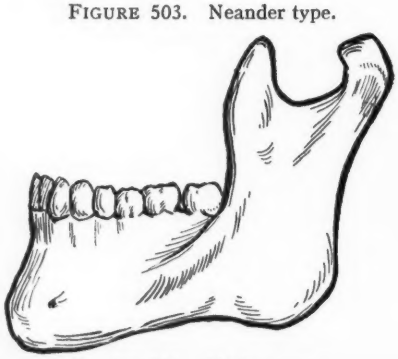


FIGURE 504. Modern man.

up in little cushion-like compartments almost exactly comparable to the pads on our fingers and toes. Although the aesthetic and sex influences may be apparent here rather more than in the bony mandible itself—for who can gainsay the charm of a softly rounded chin?—the probable origin of this cushion-like covering is to be found in the fact that the protruding chin needed a pad for exactly the same reason as do a cricketer's shins. It was into a world full of brutal tumult and hard knocks that the nascent chin first made its appearance! In the prize-ring to-day it is a well-known fact that a blow on the chin is the most rapid way of putting your opponent *hors de combat*; and, moreover, it has become apparent that the nearer the exponent of "the noble art" is in structure to a chimpanzee or gorilla the better chance will he have of wearing the glorious "Champion Belt of all the World." If we look at the bony structure of the chin in some of the prehistoric jaws, we find it of astonishing strength, being stout and buttressed as if to stand terrific violence. This is remarkably shown in Emil Selenka's admirable monograph on primitive jaws, published by Kreidel, of Wiesbaden, in 1903. From the above facts it seems reasonable to infer that man acquired such advantages as a chin can give *at his peril*; and here, again, it is suggested that some evolutionary need, of exceptional potency, moulded man's jawbone into its modern shape.

It is when we turn a human mandible round and look at it from the inside, and observe the surface beneath the central incisor teeth, that we begin to get hints as to the actual functions of the chin and the causes which have led to our deviation from ancestral type. About half-way between the rim of the central tooth-sockets and the lower edge there

are to be found in practically all European and in most other jawbones two bony prominences known as the genial tubercles (see Figure 441). Below them are two somewhat similar prominences, generally much smaller (which often appear as faint convergent ridges), which are also known to anatomists as genial tubercles; but these, I think, we need not consider of any importance in the present argument. They are to be found, not only in the lowest savages and in prehistoric men, but also in a large number of the apes and other vertebrates; indeed, I have detected apparent traces of them in those strange Permian reptiles of incalculable antiquity to which allusion was made above. They are the points of attachment for a little muscle which appears to be equally developed in man and in many of the lower creatures. It is known as the *genio-hyoideus*, and has no connection with the tongue.

A close examination of the larger bony prominences, or the genial tubercles proper, reveals some very interesting and remarkable facts, especially when we employ comparative methods. To these are attached the tendon of the fanlike *genio-glossus* muscle which spreads out beneath the whole lower surface of the central region of the tongue, and penetrates through the intrinsic muscles almost to the upper surface (see Figures 487 and 488). Now if we examine any of the current books on anatomy, little or no suggestion is found that the functions of the *genio-glossus* muscle have to do with articulate speech. Let us leave the mandible for a while and confine our attention to the structure and functions of this muscle, and I think it will soon become evident that it has more to do with the oral (as distinct from the laryngeal) machinery of articulate speech than any other structure.

In the diagrams (see Figures 489 to 494), which show the under surface of the tongue of man and other creatures more or less related to him, it is seen how remarkably this muscle has become developed since we became human. The functions accorded to it in our standard works of anatomy would apply to the needs of the dog and the pig equally to those of man; yet we see that in these animals it is a mere feeble slip of flesh which can exercise but little influence.

I have dissected it in a good many apes, among which animals it evidently had somewhat important duties quite apart from vocal production; in fact, I doubt whether in any other creature except in man we should find the tongue interfering in any way whatever in the sounds which issue from the larynx. The muscle is not only much smaller in apes than in man, but it is much more homogeneous and compact (see Figure 486); while, so far as I have been able to observe, the method of innervation shows an even greater difference than is seen in the structure of the muscle itself. To put the matter very briefly, in man the *genio-glossus* has become a series of a large number of independent muscular strips which are, to all intents and purposes, separate muscles, each with its little fibre of the hypoglossal nerve entering it in such a way as not to hamper its free movement, while in the apes it is apparently a single muscle, or a closely united group, acting *en bloc*.

It must be remembered that the adoption of an exceedingly important new method of expression and communication such as human articulate speech would require widespread and most elaborate changes in the structures which it brought into play. It is not possible on the present occasion to go into the marvellously intricate cerebral, nervous, and muscular machinery, with its innumerable bonds of coördination required for ordinary speech; but a little search into the matter will show anyone that we are here in contact with one of the most incredible marvels in Nature. Most wonderful of all, the whole mechanism is, from an evolutionary standpoint, *quite new*—a product of merely the later fragment of a brief geological period!

When we consider the number of movements, following one another in continually varying order, required for articulate speech, it is obvious that only machinery which is able to act with every mechanical advantage and with a minimum of friction, can accomplish such a task with precision. Public speakers frequently talk at the rate of one hundred and fifty words a minute, while it seems possible to articulate quite clearly and correctly when speaking at the rate of one hundred and eighty words a minute. If we analyse the action of the tongue when speaking at the rate of one hundred and fifty words a minute, we find that there must be at least five hundred different movements or adjustments. This gives eight or nine in every second! Such movements, it must be remembered, do not follow one another regularly in mechanical rotation like the piston-beats of a multiple-cylindered engine, but are continually varying their order. What wonder is it that coördination sometimes breaks down, with the result of a stutter or a stammer?

Now a brief examination of the intrinsic muscles of the tongue, *i.e.*, those that begin and end in the tongue itself like the distal muscles of an elephant's trunk, will show how totally inadequate these would be to produce any such result; but immediately one takes careful note of the mode of action of the *genio-glossus* muscle the solution of the tongue's incredible agility becomes possible.

It is seen in the accompanying diagrams (see Figures 495 to 499) that the several bundles, or *fasciculi*, of the muscle are able to act more or less at right angles to the main plane of the tongue without anything to hamper them. For each flash-like movement of the tongue away from the palate all that is demanded is an instantaneous shortening of one or other of these independent strips. For instance, in pronouncing the letter T we place the tip of the tongue against the palate close to the upper incisor teeth (see Figure 498), and then snatch it away with great rapidity. The placing it there is probably the work of the intrinsic muscle called the superior longitudinal lingual, but the

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more critical action of withdrawing it at the proper moment is due to the front fibres of the *genio-glossus, which become taut and braced for instantaneous action as soon as the tongue-tip is pressed against the palate.*

In Figure 497 it is seen that in the hard G or K exactly the same thing takes place with the central *fasciculi* of the muscle. A like action comes in with sounds involving L, N, R, D, J, Q; while in S, X, and all other consonants where the nice adjustment of the distance of the tongue from the palate is a matter of moment the *genio-glossus* muscle is capable—and appears to be the only structure capable—of exercising a quick and exact control. The same applies to the vowels, as is well shown in the accompanying diagrams after Von Meyer's drawings. Von Meyer, however, has not shown the *genio-glossus* muscle in action as it is shown here, and indeed, strangely enough, does not give it a word of mention as a factor in articulate speech.

It is worth while to take note of the fact that practically all the speech-movements of the tongue take place in the neighbourhood of its central line, and that the sides play a very subordinate part. Hence the other extrinsic muscles, such as the *hyo-glossus* and *stylo-glossus* can have little or no part in articulation (see Figure 488).

Now let us return to our inferior maxilla and examine the attachments and relations of the *genio-glossus.* It is obvious that for quick, precise movements, such as those demanded by articulate speech, it must be unhampered and have plenty of room to act. An examination of the arrangements for the play of the muscle in different animals is exceedingly instructive. In the dog, and indeed the majority of the mammalia, the tongue lies flat upon the lower jawbone leaving practically no room for any muscular machinery. If, however, a photograph of a plaster cast of the inner surface of the wolf's jaw (see Figure 471) is compared with that of the baboon (see Figures 473 and 474), which outwardly resembles it, a remarkable difference of shape is evident.

In all the monkeys—and even lower down the scale among the lemurs—we find that Nature has made provision for working room for the *genio-glossus* muscle by excavating a kind of pit on the inner surface of the mandible beneath the tongue. This pit has been noticed by various comparative anatomists, but I had never seen any explanation of the reason why it exists, nor was I aware of its function, until a series of dissections of monkeys' jaws showed in every case the tiny tendon of the *genio-glossus* coming from the lower surface of the deepest part of the pit (see Figures 433 and 486). The more doglike the jaw is, as in the baboons—the more, in fact, it corresponds in general outline with the prevalent type of the mandible among lower vertebrates—the deeper is this pit. As soon, however, as the mandible begins in some degree to resemble our own, as in some chimpanzees and gibbons, and the whole lower surface becomes tilted forwards, the pit seems to be no longer needed, and becomes shallower. One may as well remark in passing that it is of course obvious that originally the *genio-glossus* muscle had nothing whatever to do with articulate speech. The need it met in the economy of lemurs and apes was probably that of giving increased mobility to the tongue for sorting food already in the mouth. This is plainly seen when we give a monkey a nut and see him crack it and turn it about with his tongue, selecting the kernel and rejecting every fragment of shell. This ability common among all the Primates to sort food with the tongue, and with its aid to eschew unacceptable morsels, is strikingly absent in the case of most animals. Anyone can assure himself of this on seeing a dog try to get rid of some small unpalatable object. Animals such as cattle, and especially camels and giraffes, which are liable to get dangerous thorns into their mouths, depend upon a most elaborate arrangement of the long papillae lining their cheeks, so that by a simple backward and forward movement of the tongue such things are at length extruded.

There seems little doubt but that it is this sorting machinery of the tongue in the lower Primates which has been seized upon and greatly elaborated for the new and wondrous mechanism of articulate speech.

Before going further it may be as well to clear up another point which seems to have puzzled some of my audience when I was lecturing at Birmingham. The question was asked me, "How is a parrot able to talk if he has no chin?" An equally pertinent question would be, "How is a phonograph able to talk when it possesses no chin?" A parrot has deep down behind its breastbone a marvellously elaborate and versatile sound-producing apparatus, almost as different from any possessed by ourselves as is the mechanism of a phonograph. When man began to speak, he had to make use of raw material, *which was there already,* to build up his talking machinery. That the parrot and the phonograph can speak, merely proves that there are other ways of doing it; but the only question which we here have to discuss is how man did it himself with such means as were at his disposal.

When we come to examine the difference between prehistoric man and modern savages we find the same order of structural change in the mandible still going on, tending to the greater efficiency of the *genio-glossus* muscle for speaking purposes. When this fanlike group of muscular fibres came out of a deep pit, such as is seen in the illustration of the jaws of the lower monkeys, the fibres were obviously hampered by being bunched and huddled together (see Figure 486). As the jaw became tilted forward, giving more engine room beneath the tongue, the need for the pit became less, and it becomes shallower and shallower until we find it a mere depression, as in the Siamang gibbon (see Figure 435). These changes are plainly shown in the series of plaster casts of which photographs are reproduced in Figures 432 to 441. First of all is a fossil lemur, in which the jaw still retains

its generalised character, but is beginning to show depressions as the genial pit makes its appearance; then one has apes like the baboons, macaques, or colobus monkeys with an exceedingly deep pit or depression. Next come anthropoids, in which the lower edge of the jaw is already being dropped into something resembling a chin, and the depression at once becomes less apparent. Next are some jawbones of prehistoric man, namely, the Heidelberg and the Naulette jaws, in which the depression is still plainly seen and is scarcely less marked than in the gibbon.

It will be seen that the Heidelberg jaw shows on its surface a tubercle; indeed, I understand that one of the descriptions of it published soon after it was found stated that it did not differ from modern jaws in this respect (see Figure 464). A brief comparison with the other casts, however, will make it plain that the tubercle here seen is too low down to be that for the *genio-glossus*, and is plainly the one for the *genio-hyoid* muscle mentioned in the earlier part of this article, which has nothing whatever to do with the tongue. This tubercle is quite common among the apes.

When we come to the Pygmies and Bushmen we find in the majority of jaws the remains of this pit or a mere flat surface; but in some African dwarf races, and among the Hottentots, Veddahs, and Andamanese, two little prominences are seen beginning to grow at the lower edge of the pit (see Figures 442 to 452). These tubercles, as we pass to higher and more civilised races, become more and more prominent, until we get the European type familiar to all students of anatomy.

Now the bearing of these changes on the functions of the *genio-glossus* muscle is fairly evident. First of all, it needed a deep pit in the lower apes to get room to work at all. Then the depth of the pit became unnecessary through the tilting of the lower surface of the mandible; and by means of this change the muscle was obviously given greater freedom for action. Then we get a nearly flat surface; and finally a prominence appears, enabling the separate *fasciculi* of the muscle to spread from the very point of origin and so act independently without hampering their neighbours (see Figures 441, 455, 461, and 465).

We are thus able to follow the whole course of the history of the *genio-glossus* muscle from fossil lemurs to modern men, and a very remarkable history it is, difficult, I believe, to parallel in any other structure of the body which we may pick out for the purpose. We found it in the lower apes, in which it first appears as an important factor in tongue movements, coming out of a hole in the lower jaw, and we take leave of it mounted upon a pinnacle quite as high as the pit was deep (see Figures 486 and 487). This is as if an organism commenced its career in the uttermost depths of the sea, and attained its full development at the top of Mount Everest! The muscle might stand above all things else in our bodies as a symbol and sign of our upward progress. For I think it cannot be denied that its development marched *pari passu* with the development of intellectual capacities and the increasing need of a means of clear expression.

When speech began, as distinct from mere animal stereotyped cries and other noises, it is, of course, impossible to say. For the speech of certain low savages, consisting of grunts, guttural sounds, and clicks, it is fairly obvious that few tongue movements are necessary; but wherever languages have become more elaborate—and many of them in different parts of the world appear to have had an independent origin from more brute-like utterances—we find that the *genio-glossus* muscle comes more and more into play, as is evidenced by its tubercles of attachment and by the forward tilt of the chin to give elbow room among all the higher races.

The speech of monkeys is, of course, a myth, and most of our anthropoid friends are curiously silent beings. The two exceptions appear to be the chimpanzee, which is described by travellers as shouting and calling in varied tones in the forest, and certain gibbons, which appear to come nearer to us in the variety of articulate utterances than any other of the Primates. From the series of plaster casts shown in the plates, and in many others that are in my possession, it seems to become evident that, speaking generally, the genial tubercles may be taken as some index of social and intellectual development. They are not, of course, strictly necessary for speech, but it is clear, both from anatomical and general reasons, that they greatly facilitate speech.

It is interesting to watch their development in the normal human subject (see Figures 453 to 455), and I have several casts which illustrate this fairly clearly. In all young children they are absent, and up to the age of fourteen years they make but a small show; in fact, the jaw of a child of fourteen years almost exactly resembles in this respect that of a Bushman or Pygmy; between fourteen and seventeen, however, they appear to obtain their full development. How far that development is dependent upon the use of the muscle it is difficult to say; my own belief is that, like many of the roughnesses and ridges upon our bones, they are very largely the product of vigorous muscular action, *i.e.*, Nature has met the obvious need of the muscle by altering the bone in a certain specific direction.

For many years I have been endeavouring to get evidence as to the presence or absence of the tubercles in deaf mutes. Such as I have, so far as it goes, seems to show that in adults who have never acquired articulate speech they are quite absent (see Figure 440). In the one specimen I have from a deaf mute, the bone almost exactly resembles that of a Bushman, or a child of fourteen.

A glance over the peculiarities of the tubercles in the accompanying plates shows how extraordinarily variable they are in different individuals and in different races (see Figures 457 and 458), but before any safe generalised conclusions are drawn

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from these diversities one ought to have many thousands before one for comparison. It seems to me quite probable that this would prove a fruitful line of research for anyone with leisure and opportunity to follow up; for, when we consider the distinct anatomical problems involved in the pronouncing of different languages it seems not improbable that definite structural peculiarities might become apparent in accordance with the "tongue" spoken. We know that it is practically impossible for Europeans to acquire the elaborate tongue and throat movements of not a few barbarous languages, and it would be extraordinary indeed if this wide diversity in muscular function did not leave some trace which the methods of the anatomist might reveal.

In Figure 465 is reproduced a photograph of a cast from part of the jawbone of O'Brien, the Irish giant, the capture of whose body gave John Hunter so much trouble. I placed it there, because it shows the typical arrangement of the genial tubercles in a very marked manner. It also tells us something else, which I think is not a little instructive. There can be no question that the Irish speak our language with much greater correctness and precision than the average Anglo-Saxon, and further investigations seemed to show that in Irish jaws there was a fuller development of the genial tubercles than in those found in English museums. On following the same line of research a little further it became apparent that a greater symmetry and uniformity of the development of the genial tubercles was to be found in French and Italian jaws than in English. This seems to be a matter well worth following up.

A few other suggestive points come out from a further examination of the plaster casts, reproduced in the plates, which have no very direct bearing upon our present enquiry. One, for instance, is the obvious kinship between certain American monkeys and the lemurs, as evidenced by the duplicated pit (see Figures 475 and 476). In nearly all the Old World apes of which I have specimens, the two cavities appear in close proximity or merged into one, but in the American monkeys and the Madagascar lemurs they are generally separated by a marked interval. The lower jaw in certain highly specialised apes, such as the howler and proboscis monkeys, appears very difficult to interpret. Here again a more extended collection, giving opportunities for exact comparative methods, would be certain to throw a good deal of light on what is at present a subject which seems to have been very little studied.

Apart from these by-products of the enquiry I think it will be acknowledged that many of the facts put forward in this article go far in justifying my suggestion that the chin, which is so marked a characteristic of the modern human mandible, may be considered part of the necessary mechanism of articulate speech.

NOTE: *The illustrations in the above article are by Mènie Gowland.*

REPORTS.

THE YORKSHIRE NATURALISTS' UNION.—By the unanimous vote of the council of the Yorkshire Naturalists' Union the President for the next year will be Mr. T. Sheppard, F.G.S., of Hull. The Yorkshire Naturalists' Union is one of the most successful associations of its kind in Great Britain, and has published many important monographs on the flora and fauna of the county, and also issues *The Naturalist*, which is one of the oldest scientific monthly magazines in the country. The Union has a membership of nearly four thousand, and about forty important natural history societies are affiliated with it. Until recently Mr. Sheppard was the Honorary Secretary, and took a leading part in the editing and publishing of its important monographs, and there is no doubt that it is largely due to his efforts that the Union owes its present influential position. Mr. Sheppard is well known from the excellent work he has done in connection with the three municipal museums at Hull. He is the author of numerous books and monographs, as well as of the remarkable series of Hull Museum Publications, close upon a hundred of which have been published during the past fourteen years. He has already filled the presidential chairs of the Yorkshire Numismatic Society, the Hull Geological Society, the Hull Literary Club, the Hull Scientific Club, and the Hull Shakespeare and Playgoers' Society.

CAN LEAD BE TURNED INTO GOLD? — At a meeting of the Alchemical Society on Friday night, October 10th, Professor John Ferguson, M.A., LL.D., and so on (of Glasgow University), delivered an interesting address on English Alchemical Literature, in the course of which he said the English literature on the subject was not very bulky although it might be precious. Other chemical and technical processes had very extensive literature in which the various discoveries were traced. So far as he knew there was no gold made by alchemists in existence at the present time. When they saw a gold medal they knew it was gold, but there was no proof that gold was ever made from mercury, lead, or any other metal. Even if a piece of gold was produced which was alleged to have been made by an alchemist, they had no knowledge at present as to how it was done. He had never come across an old book or manuscript on alchemy which ever explained the method by which base metals could be transmuted into gold. There were many manuscripts extant at the British Museum and the Oxford Library bearing on the subject, and in them one could find enough material to occupy his whole attention for many years.

He did not propose to deal with the manuscripts because of their great abundance and also because of their inaccessibility, but would confine his remarks to books printed in the English language on the subject. There were many books in Latin whose authors are Englishmen, but he had not time to deal with them. The earliest printed book on alchemy was published somewhere about the year 1474 or 1480. Probably it had been taken from a manuscript, and so far as he knew it was the only book on the subject printed in the fifteenth century. A number of books were printed in the sixteenth century, and still more in the seventeenth century, but after that the number declined, and during the eighteenth century and nineteenth century most of the books dealing with the subject were reprints. The lecturer then dealt in great detail with the various authors, most of whom claimed to have discovered the secret powder for transmuting base metals into gold. There was a wide field for research work among the manuscripts at the British Museum and the Oxford Library. Whether any of those manuscripts contained the precious secret he did not know, but he hoped that now he had called attention to the literature on that subject it would lead others to investigate the matter, which was a very interesting one.

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THE NOMENCLATURE OF VARIABLE STARS.

By F. A BELLAMY, M.A., F.R.A.S.

THE present state of chaos in the nomenclature used for variable stars—and it is daily increasing—calls for careful consideration by astronomers to remove some of the present anomalies, and, in view of the immense increase in the number of known variable stars—which will be still further increased by photographic means—to establish some definite, convenient, intelligible, and permanent notation.

The beginning of astronomical observations of the variability in the light of stars may be placed in the year 1572 with the discovery of the star which is usually known as Tycho Brahé's *Nova* in the constellation of Cassiopeia, or sometimes as B Cassiopeiae. In the next hundred years three more such stars (*Novae*) were discovered in 1600, 1604, and 1670, and are known as P Cygni, a star in Serpentis, and 11 Vulpeculae. Until about one hundred years ago not many observations of the variability in the light of stars, or of *Novae*, are recorded. Systematic and careful estimations of the magnitudes of certain stars were made about seventy-five years ago, chiefly by Schmidt (of Athens), Argelander (of Bonn), Heis, and, later, by Hind, Pogson and J. Baxendell in this country: their observations soon proved the degree of variation of light in a number of stars they had kept under frequent observation; and, incidentally, these observers—to be more precise Argelander and Pogson—laid the basis of the scale for accurate stellar magnitudes, and afforded us both the means of determining relative magnitudes and of carrying on a magnitude scale with a definite light-ratio. One may say quite fairly that for the last seventy years all visual estimations of stellar magnitudes have been made on this basis (Argelander and Pogson) without change, and Pogson's value of the light-ratio, or difference in the star's light from one magnitude to the next, of 2·512, or logarithm 0·400, has since been universally adopted, though Professor E. C. Pickering's latest photometric work indicates a slightly different value; also he proves that Argelander's magnitudes of the fainter stars observed, 8·0 to 9·5 magnitude, require diminishing by some tenths of a magnitude: this is probably due to the small size of Argelander's telescope, which is still *in situ* at Bonn as when last used by Argelander and Schönfeld. This by way of a parenthesis to indicate the origin of accurate stellar magnitudes; for, without a uniform basis, the observations upon variable stars for the determination of their periods would be useless.

Returning to the definite subject of this note, the first catalogue of variable stars appears to have been that formed and published by Argelander in 1844, and was published in Schumacher's " Jahrbuch," on page 214. This catalogue contained eighteen stars only, and all were well situated for observation in what is now the German Empire: it may be of interest to give them.

FIRST CATALOGUE OF VARIABLE STARS.

o Ceti, β Persei, χ Cygni, R Hydrae, R Leonis, η Aquilae, β Lyrae, δ Cephei, α Herculis, R Coronae Borealis, R Scuti, R Virginis, R Aquarii, R Serpentis, S Serpentis, α Cassiopeiae, α Orionis, α Hydrae.

The capital letters have been added to some of these stars. The stars, when read horizontally, are in the order of discovery; *Novae* were omitted by Argelander; they are mostly bright stars, and ten of these have the old Greek notation, which remains in variable star nomenclature as for all other astronomical purposes. Of the other eight, seven have the prefix R, and one the letter S. As some of the capital letters beginning at A had already been used by Bayer, about two hundred years earlier, Argelander formed the scheme of applying the letters of the alphabet, beginning at R, to the stars shown to be variable, other than those already designated with Greek or other letters. So soon as enough variable stars had been discovered to require the letter *Z*, the sequence was to be continued with the duplication or combination of letters; thus after *Z* the next in the series would be R R to R *Z*, S S to S *Z*, and so on to *Z Z*. The necessary complement of these prefixes was the name of the constellation; so the full designation for a variable star might be R Andromedae, R R Aquarii, or *Z Z* Cygni. This form of nomenclature was sufficient for forty-five variable stars in each constellation. Until a few years ago the discovery of new variable stars depended upon visual work, and this nomenclature sufficed for all needs. With the greater application, or rather a closer examination, of the many thousands of photographs that have been taken at Harvard College and other observatories (mainly at Harvard), the number of new variable stars is being increased by hundreds a year; the result is that the method of Argelander has broken down—at least for certain constellations.

In 1909 the number of variable stars was more than forty-five (= *Z Z*) for the constellation of Cygnus. Recourse was then had to the dual use of the letters beginning with A A—single letters could not be used, for, as I have pointed out, many single capital letters were already in use for non-variable stars. The continuance of this notation,

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it is intended, shall run on after *Z Z*, with the letters A A, A B, A C, and so on, prefixed to the name of the constellation. If this part of the dual notation be not continued beyond A Q, B Q, and so on, there will be provision for one hundred and thirty-six additional variable stars in each constellation. If it be continued, as is being done in Hartwig's Ast. Gesell. annual catalogues, from A A to A *Z*, as far as Q Q to Q *Z* (always omitting J), then there will be provision for two hundred and eighty stars, besides the fifty-four from R to *Z Z* for each constellation.

In 1909 there were eighty-six constellations in which one or more variable stars had been discovered. The state of this lettered nomenclature in 1909 was that in the constellation of Scutum there were nine lettered variable stars and thirty-one waiting for letters, in Sagittarius twenty-seven lettered stars and seventy-four waiting, in Scorpio twenty-five lettered stars and eighty-four waiting, and in Orion there were nine lettered stars and one hundred and twenty-five waiting for letters of identification. In 1912 the constellations of Cygnus, Scorpio, Sagittarius, Centaurus, Carina, Aquarius, Aquila, Hercules, Andromeda, and Draco had almost exhausted the R to *Z Z* section of the alphabet; in fact, A K was reached for Scorpio, A O for Sagittarius, while for Cygnus the alphabet with dual notation had been passed through once, and A *Z* reached. For Scorpio there were thirty-nine more lettered variable stars than in 1909, and yet there were forty-five more already discovered and waiting for letters. At the rate at which variable stars are being photographically discovered it will require but two or three years, perhaps, for the whole alphabet to be used up in the dual form. To continue to ring the changes with triples would be cumbersome. The single or double letter form with the figure 3 as an index might be convenient, both for manuscript use and print, as R^3, S^3Z, or A^3Q; but any extension of the scheme by mere variation of printers' type—as has been suggested—would be extremely inconvenient, and a source of many errors.

We shall now return to the historical side of the subject and resume the thread of Argelander's Catalogue of 18 variable stars published in 1844.

Though the lettered nomenclature had been in use for some years, Argelander had given no very definite account of the scheme until that which appeared in the *Astronomische Nachrichten*, No. 959, 1855, May 3rd; this explanation may be given best in his own words:—

"Mit *R* bezeichne ich den Stern in der Jungfrau, dessen periodische Veränderlichkeit Harding im Jahre 1809 entdeckt hat, und dessen Position für 1855 ist: $12^h\ 31^m\ 9^s + 7°\ 47'\cdot 3$. Dass ich einen nicht bei *Bayer* vorkommenden Stern mit einem Buchstaben bezeichne, wird mir hoffentlich nicht verdacht werden. Die veränderlichen Stern haben bei ihrer Merkwürdigkeit wohl ein Anrecht auf eine solche Auszeichnung, die zur Bequemlichkeit der Nachweisung bei so oft erwähnten Sternen fast unentbehrlich ist. Um aber eine Verwechselung mit den *Bayer*'schen Buchstaben möglichst zu vermeiden, habe ich die letzten des Alphabets gewählt, und sie dem grossen Alphabete entnommen. Nur im Hercules gehen die lateinischen Buchstaben bei *Bayer* bis $\varkappa$, im Stier bis *t*, in der Jungfrau bis *q*, im Löwen, Orion und Schwan bis *p*; im letztern Sternbilde ist dies ein grosser Buchstabe. *Bayer* kennt sonst für seine Bezeichnungen in den Sternbildern von den grossen Buchstaben nur das *A*; die andern grossen Buchstaben, die auf seinen Charten vorkommen, weisen entweder auf hellere Sterne benachbarter Sternbilder hin oder auf ausgezeichnete Puncte der Himmelskugel. Nur bei dem bekannten neuen Sterne vom Jahre 1600 macht er eine Ausnahme, indem er ihn mit P bezeichnet; er sagt: 'P tertii fulgens stella, anno MDC primum conspecta et observata, omnium ferme tacito consensu pro novo phaenomene recepta, eundem adhuc hodie retinet situm e.q.s.' Ich könnte somit *Bayer* als meiner Vorgänger bei dieser Auszeichnung der veränderlichen Sterne citiren; indess glaube ich, dass dieser Astronom daran nicht gedacht hat, sondern den Stern in seiner vor 1600 schon fertigen Charte, vielleicht erst auf der Kupferplatte, nachgetragen, und desshalb die Ordnung nicht unterbrechen wollte; er hätte ihn sonst nach seiner Methode mit γ, γ mit δ bezeichnen müssen, u-s-w, also wären alle folgenden Sterne geändert worden."

The nomenclature proposed and used by Argelander was generally adopted. Here is an example by Dr. R. Luther (Bilk) in *Ast. Nach.* No. 996 (1855, November 29th): "welcher nach dem Argeland'schen Vorschlage (in No. 959 der *Ast. Nach.*) T Piscium bezeichnet werden möge."

Argelander's Catalogue was followed by Norman Pogson's pioneer work at the Radcliffe Observatory, and he published a catalogue of 53 stars in 1854, using Argelander's notation; G. F. Chambers, who is still living, published a list of 123 variable stars in the *Astronomical Register*, II, 194, in 1864, August; this was reprinted in the *Astronomische Nachrichten* in Band LXIII, page 117; a revised form also appeared in the *Monthly Notices of the Royal Astronomical Society* vol. XXV, page 208 (1865, May), and in later years catalogues of 235 variable stars, 126 probably variable, and 500 red or orange stars in his *Handbook of Astronomy*. In these catalogues he was helped by J. Baxendell, G. Knott, F. Brodie, and J. E. Gore. In 1865 and 1875 Schönfeld published catalogues. The number then given was 143 stars: to this number 48 variable and 77 suspected variable stars were added at Harvard Observatory in 1883, and further lists were published from Harvard in the *Proceedings of the American Academy of Sciences*, vols. XIX–XXII. In 1888 an Index to observations of variable star (published) observations was given in the *Annals of the Astronomical Observatory of Harvard College*, vol. XVIII, No. VIII: in this 225 stars are given and the records of 125,720 observations made from 1838–1888 are indicated.

Chandler published in *The Astronomical Journal*, vol. VIII, 81 (1888), a catalogue of 225 variable stars, with their elements, and a great deal of other information; a second edition, containing 260 stars, was published in *The Astronomical Journal*, vol. XIII, page 89 (1893); and a third and last edition, recording 393 stars, was published in *The Astronomical Journal*, vol. XVI, page 145 (1896). Soon after this Roberts published a catalogue of 94 stars south of $-23°$ Dec., a portion of the sky previously much neglected.

Chandler adopted an entirely new notation in his three catalogues; we give the reasons for the method in his own words:—

"The number of a star, upon a system of ordinal notation designed to remedy the inconveniences attending the usual current numbers . . . . if the numbers of any one list are retained, the interpolated stars require a suffix letter, resulting in a hybrid notation which is exceedingly objectionable, and which sooner or later has to be reformed; when the whole process of degeneration, with its awkwardness and confusion, begins anew. It seems certainly better to adopt a system which attaches a permanent numeral to each star, and which permits interpolation to a practically unlimited extent. I would accordingly suggest that the numbers for variable star catalogues be *one tenth of the right ascension, expressed in seconds of time, for the equinox 1900·0.*"

This method limits us to 8640 variable stars in the whole sky unless we adopt the "hybrid notation" disparagingly referred to in the above quotation.

The publication known as the *Vierteljahrschrift der Astronomischen Gesellschaft* has contained, since 1870, a list of variable stars with ephemerides. The work was edited or compiled formerly by Winnecke, Schönfeld, and at present by Hartwig. Up to 1889 it contained stars to 2° south of the equator; from 1889–1895 stars as far south as − 30° Dec. were included; from 1895–1902 the catalogues were extended to − 35° Dec., and after that variable stars in the whole sky were included; the catalogue of 1906 contained information for 709 stars similar to that in Chandler's catalogues. The number in the catalogue for 1913 is 962 stars north of − 23° Dec. and 417 stars south of that. During the year 1912 148 new variable stars were discovered, 109 from photographs and 39 visually; since 1900 about 80 per centum were found by ladies, chiefly from Harvard and Arequipa photographs. The non-continuance of the preparation for further editions of Chandler's catalogue resulted in more attention being given to variable star work at the Harvard Observatory. For some years Professor W. M. Reed had been forming a bibliography of variable stars, on cards, giving the details for separate stars, and in 1897 this extensive record had needed 15,000 cards; then it was continued upon similar lines by Miss Cannon, who added 20,000 cards; and the results of Professor Reed and Miss Cannon's work formed volume XLVIII, No. III (published in 1903), and was called the Provisional Catalogue of 1,227 stars, and is usually considered to be the first catalogue of variable stars independently formed at the Harvard Observatory. A supplement was published in *The Harvard Circular*, No. 77, and a further supplement is in *Harvard Annals*, volume LIII, No. VII. The continuation of this work at Harvard with still greater vigour, aided by an exhaustive and comparative examination of portions of the Harvard extensive series of photographs, revealed a large number of new variable stars, and a new catalogue was required. The volume LV, under the joint editors, Miss A. J. Cannon and Professor E. C. Pickering, was published in 1907 to 1909 to replace the former first and provisional catalogue, and it extends to 291 pages, entirely devoted to variable star work. This second catalogue contains 1,957 stars, with a supplementary list in Table IX (page 272). On page 103 of volume LV begins a list of 167 observers and observatories which have contributed the observations included.

The variable stars discovered in the globular clusters are included in this number 1,957, but not those 1,791 variable stars already discovered in the Magellanic clouds. To December, 1906 only, there were 3,748 variable stars to be dealt with: of these, 2,909 have been discovered at the Harvard Observatory, mainly from photographs taken there and at Arequipa; 514 of these 2,909 stars were found by S. I. Bailey in southern globular clusters, 221 more were detected by Mrs. Fleming from an examination of third-type spectra (photographs taken for the Henry Draper Memorial), and Miss H. S. Leavitt has discovered 2,110 of the total 2,909 stars; they were mainly in the Magellanic clouds.

The Harvard Observatory publications and work upon variable stars really mark the introduction of an entirely new system, and this brings us to the third form of nomenclature. The great accession to the number of variable stars in recent years, largely owing to the extensive use to which the photographic gelatine plate has been put, caused Professor E. C. Pickering to form some easy, permanent, and inexhaustible method of nomenclature for variable stars, and one that would at the same time afford some other information than a mere name.

The scheme which he first adopted in the Harvard Provisional Catalogue was numerical in form, yet not a mere number, but figures which also give the position of the star in the sky with sufficient accuracy to enable an observer to remember or ascertain from an abbreviated or compact list—without the necessity of consulting a large catalogue—whether the star is suitably situated for observation. The form of designation which was adopted for the Harvard Provisional Catalogue is retained in the second catalogue of variable stars in Vol. LV. The method has been found of great convenience in actual practice. It is in constant and daily use at that observatory, and the six figures, to be read as three pairs, are quite readily retained in the mind for all stars frequently observed, and the accuracy indicated by the figures is sufficient to enable the observer to set the 6-in. telescope and identify the variable star field readily.

The plan is to give the hours and minutes of the star's R.A. for 1900, omitting *all* seconds (*not* the nearest minute) and the degrees of declination, omitting all minutes; when there are several variable stars with the same hours and minutes and the same degree, as sometimes occurs in clusters, then a small letter is added beginning with a, b, c, and so on; in no case yet, we think, has more than a single letter been required. Though the method is really independent of the constellations it is better

XUM

to give them; the designation almost always indicates the constellation. The most unsatisfactory point in the scheme appears to be the dual character for the northern and southern stars; if the constellation be given as well as the number all would be clear for stars in those constellations beyond fifteen degrees from the equator. But for those, as Cetus, Orion, Aquila, and so on, which embrace stars on both sides of the equator some additional and distinctive notation must be introduced, and Professor Pickering continues his custom—as in all his photometric and other work—of designating all negative quantities in print in italic type. In a bad light, or when using a catalogue quickly, one is apt to overlook the italic type, this is the chief objection to the method; but the introduction of a minus sign would give emphasis to the star being in the southern hemisphere.

Had north polar distance (N.P.D.) been adopted instead of declination this difficulty would have been overcome; but N.P.D. is very seldom used in practice, and not many instruments are so graduated.

Let us see how the second Harvard Catalogue looks. This is a portion of one page:—

Designation.	Name.	D.M.	R.A. 1900.		Dec. 1900.	
			h.	m.	°	′
181912	— Scuti ...	5045	18	19·9	−12	45
182109	— Scuti ...	4376	18	21·1	− 9	15
182158	R Z Draconis...	...	18	21·8	+58	50
182513	X Scuti ...	5014	18	25·7	−13	11
183149	S V Draconis...	R	18	31·2	+49	18
183146	— Lyrae ...	...	18	31·6	+46	3
183107	— Scuti ...	4633	18	31·7	− 7	41
183208	Y Scuti ...	4663	18	32·6	− 8	27
183342	— Cor. Aust.	13498	18	33·6	−42	20
183647	— Telescopii	12488	18	36·5	−47	21
183604	— Scuti ...	4553	18	36·7	− 4	13
183606	— Ophiuchi...	...	18	36·8	+ 6	20

Two-thirds of these had no letters in 1907.

It will be appropriate to make a quotation here from *The Annals of the Harvard Observatory*, vol. LV:—

"The number of variable stars has now become so large that it is necessary to have some convenient means of referring to them and of locating them. The numbers given by the editor of the *Astronomische Nachrichten*, while very useful for certain purposes, are not convenient as permanent reference numbers for the stars. In reading an article which merely gives, for instance, 21, 1909 Andromedae, one is at a loss to recall just where the object is, or whether it is suitably placed for observation. For this purpose a list must be consulted to find the position of the object. On the other hand the designations used here serve to locate the star. They give the hour and minute of right ascension and the degree of declination. This is often all that is needed. An observer can at once make up his mind whether the object can be observed at present or at a later time. The objection has been raised that six figures cannot readily be remembered. On the contrary, it is found here that they cling to the memory with remarkable tenacity if constantly used in connection with each variable. An observer here,* by whom these [numerical] designations are used daily, recently made a test. He wrote down the names of 367 variable stars. For 260 of these stars he supplied from memory the designations correct in all six figures."

This quotation introduces the fourth form of nomenclature now current. It is convenient as a temporary expedient, but we think it should be abandoned as being cumbersome and overlapping. The *Astronomische Nachrichten* notes the discovery of variable stars, and each year the series begins with No. 1 (with the constellation added); so, unless one is careful to add the year, confusion will soon arise. From this temporary method of nomenclature the star is advanced to the lettered form, but that may not be until some years have elapsed and the star has been proved to be variable.

The application of letters to the variable stars is years in arrear; the general result is that we have four forms of nomenclature for variable stars in current use.

There is yet a fifth method. Each year, as already mentioned, there is a catalogue of variable stars edited by Hartwig, and published in the *Vierteljahrschrift der Ast. Gesell.*; the stars (in the list for 1913) are numbered from No. 1 to 962 in order of R.A. for epoch 1855·0, and include only the stars to −23° declination; those south of −23° begin at No. 1001 to 1417, but in order of R.A. for 1875·0! At the end of these annual catalogues there is an alphabetical arrangement of the constellations with the appropriated letters, to which is added the number in the catalogue. So, as new stars are added each year, the catalogue number for, say, R Aurigae will differ almost every year. As only about 1,400 variable stars are given in Hartwig's catalogue for 1913, and 3,748 are given in the Harvard Second Catalogue to the end of 1906, it is presumed that when the number 999 is reached the next thousand will have to be skipped and continue the northern list at 2,000: this is encouraging confusion. The epoch for the Harvard Catalogue is the same convenient date as for the International Astrographic Survey, 1900; and it would save much time and be of the greatest advantage to practical astronomy in all its branches, if all positions of stars, whether approximate or accurate, were always given for this epoch (1900·0) for the next thirty or forty years, when 1950·0 might be adopted until the year 2000.

Those interested in variable star work have therefore at least five forms of nomenclature and three different epochs to amuse themselves with, besides variations for north and south stars. In view of the fact that continued rapid accessions of new

* The Observatory of Harvard College.

variable stars are being made to the total, now well over 4,000, and that only 1,400 of these have lettered names, it would greatly benefit astronomy and be to the credit of astronomers if some international consensus of opinion were obtained, and a definite and, as far as possible, a permanent scheme were evolved from the present confusion.

In Chambers's "Handbook of Astronomy," Vol. III, page 271, we read: "Argelander's very crude and unsatisfactory nomenclature (*Astr. Nachr.*, XL, 959, 1855, May 3) has been followed, but at no very distant period it will have to give place to something more artistic." And he wrote as long ago as in 1865: "The time seems arriving when it will be imperatively necessary to adopt a new nomenclature for variable stars. The present system, besides being inartistic, is gradually, and not very slowly either, drawing to a natural termination."

This period has undoubtedly arrived, and, whether or not Professor E. C. Pickering's scheme is more artistic, it is certainly very convenient, of great utility, capable of indefinite expansion, and with some modifications, might very well hold the field.

To show how compact and convenient Professor Pickering's method is we shall conclude this article by giving a sample of the form in which Professor Pickering has arranged a table for all the variable stars with letters (to 1907). The whole catalogue of lettered stars can be given on four or five pages. Here is a sample (see Table 81).

The first star R Andromedae has R.A. 0^h 18^m and Dec. + 38°; RT Andromedae has a note; SR, TR, TS are not used, only letters in *direct* sequence; thus, for Cygnus, there are no stars for XR to XW, YR to YZ, or ZR to ZY. All the stars under Antlia have south declinations, also most of those under Aquarius. There seems no valid reason why letters and Professor Pickering's notation should not be applied immediately a discovery—with sufficient verification—in the star's light is announced; we should get rid of the second, fourth, and fifth variations in nomenclature and two different epochs. Even if the star should eventually prove to be non-variable no harm would be done; in 1920, 1930, 1940, or even every five years from 1915, the catalogues could be swept clean of those spurious variable stars and the letters appropriated for others. The order of the letters is no longer coïncident with the order of discovery, and no chronological significance would be disturbed.

TABLE 81. INDEX TO DESIGNATIONS OF VARIABLE STARS.

Constellation.	R.	S.	T.	U.	V.	W.	X.	Y.	Z.
Andromedae ...	001838	003740	001726	010940	004435	021143*a*	001046	013338	232848
" R	004533	235048	*r*	013238	020448	004132	005840	231539	230552
" S	...	230752	233335	235943	235939	001828	012746	000843	225442
" T	...	...	230845	002725	225342	...	...	...	...
Antliae... ...	*100537*	*092728*	*092936*	*103039*	...	...	...	...	...
Aquarii ...	*233815*	*225120*	*204405*	*215717*	204102	*204104*	*221321*	*203905*	*234716*
" R	*210903*	*210504*	*221722*	*231917*	*210000*	211800	...	...	...
Cygni ...	193449	200357	204334	201647	203847	213244	203935	204834	195849
" R	204244	200938	194048	213753	213937	202539	200747	200635	204846
" S	...	213843	202954	194029	200647	200346	201130	194232	202946
" T	...	...	193732	194348	203046	210129	205642	192928	191350
" U	...	...	...	213542	192843	201942	205030*a*	205230	215543
" V	...	...	...	...	210245	201134	205339	210039	214742
" W	...	...	...	...	...	200041	201437*b*	214443	204938
" X	...	...	...	...	...	...	200158	194541	193056
" Y	...	...	...	...	...	...	...	211841	205840
" Z	...	...	...	...	...	...	...	...	202046

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

YERKES PARALLAX DETERMINATIONS.—The *Astrophysical Journal* for July contains a further series of parallax determinations by Messrs. Slocum and Mitchell. Only four stars on the present list have parallaxes notably exceeding their probable errors, and three of these are faint. μ Orionis has a parallax of ·″036; Groningen VII, number 20 (RA 16^h 21^m, N. 48°·6), whose magnitude is only 10·7, has a P.M. of 1″·22 and parallax ·″125; an anonymous star, RA 17^h 33^m, N. 18°·6, magnitude 9·1, has parallax ·″108, PM 1·″36. Curiously enough, there are two other ninth-magnitude stars close to it which also have large, though not identical, P.M.'s, but their parallaxes are insensible. The remaining parallax is an 11·3 magnitude star near 17 Lyrae, whose P.M. is 1·″75, parallax ·″124; its intrinsic lustre must be extremely small; if its surface were of the same brightness as our Sun's its size would be comparable with Jupiter's.

WESTPHAL'S COMET.—This comet, which appeared in 1852, has now been detected on its return by M. Delavan at the La Plata Observatory, Argentine Republic, of which Professor Hussey is Director. It was seen at Greenwich on September 30th, when it was of eighth magnitude and about 3′ in diameter, with distinct central condensation. On November 1st its place will be roughly R.A. 20^h 38^m, N. 24° 50′; November 11th R.A. 20^h 33^m, N. 31° 7′. The following are the elements: Perihelion Passage, 1913, November 26·1, Omega 57¼°, Node 346¾°, Inclination 40° 57′, Perihelion Distance 1·25, Period 61·12 years. The perihelion passage is about a

month later than the time that would give the best display. In 1852 it was on October 12th, or a fortnight before the time of best display. It is fortunate that the conditions should be good at two consecutive returns. There is little doubt that the comet will be faintly visible to the naked eye at the time of perihelion; it will doubtless be visible in a binocular throughout November.

This is the fourth member of the Neptune comet family to be observed at a second return. The others were Halley, Olbers, Pons-Brooks. There are two others, seen in 1846 and 1847, whose returns are expected about 1921 and 1927. Westphal's has much the shortest period of the family. Its aphelion distance is thirty, exactly Neptune's distance, but there is not a close approach to Neptune's orbit, owing to the large inclination. The time of perihelion is five months earlier than that predicted as the most probable by Hnatek and Viljev. This illustrates the difficulty of accurate prediction in a period of this length.

THE PLANETARY DISTANCES.—I lately received from Professor Lowell an interesting essay on the planetary distances and their bearing on the question of the manner of development of the system. He points out how often the periods of two adjacent planets approximate closely to some simple ratio. Thus:—

Mercury to Venus Jupiter to Saturn	...	...	= $\frac{2}{5}$	
Venus to Earth	...	...	= $\frac{3}{5}$	($\frac{8}{13}$ closer)
Earth to Mars	...	...	= $\frac{1}{2}$	($\frac{8}{15}$ closer)
Saturn to Uranus	...	...	= $\frac{1}{3}$	
Uranus to Neptune	...	...	= $\frac{1}{2}$	

He suggests that there is not only a coincidence but a law here, and that "each planet has formed the next in order at exactly one of these commensurable points, at the same time displacing it slightly Sunward."

He points out that the action of an outer planet on an inner practically diminishes the Sun's mass and increases the period, while the action of an inner one on an outer increases the Sun's mass and diminishes the period, the second case being the more effective. Thus a planet once formed tends to draw neighbouring particles to itself by bringing their periods into conformity with its own.

He then proceeds to consider the effect of commensurability of motion, showing that there is a tendency for particles to swing about the commensurate position; he suggests that in time this leads to the building-up of a planet at this position. The planets would thus have been formed from the inside outwards, "each acting as a sort of elder sister in bringing up the next." Jupiter is supposed to have been formed antecedently to the commencement of this action, and Saturn, Uranus, and Neptune to have been formed outside in succession, each being drawn slightly Sunward from the point of exact commensurability. Thus is explained the youthful appearance and small density of Uranus and Neptune. Had they started at the same time as Jupiter, their small size would lead us to expect further development and greater density. Saturn, on this view, is the youngest planet as regards stage of development reached, which accords well with the very small density and the presence of the ring.

The four inner planets are supposed to have been formed in a similar manner. The present condition of Mars is quite consistent with an origin later than that of the Earth; for in spite of its small size it has evidently not yet reached its "dead" stage. Professor Lowell points out that though there are gaps in the minor planets at the distances corresponding with periods one-half, two-fifths, and one-third of Jupiter's, yet the great bulk of them is concentrated near these points. He suggests that we see here the same congestion of matter as caused planetary aggregation elsewhere, but in this case it proved abortive.

The paper is an interesting attempt to give a physical explanation of the existing planetary distances. He ventures to predict the distance 47·5 (period 328 years) for the planet outside Neptune. From the analogy of the satellite system he thinks it likely that it would have a large eccentricity and inclination. This would make its discovery more difficult, as a much wider zone would have to be swept.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S

RECENT RESEARCH ON EMBRYOLOGY OF ANGIOSPERMS.—(*Continued from page 384*).

Schoute's work on the exact relationship of plerome and periblem at the growing-point to the central cylinder and cortex as differentiated in the older regions of the same axis, whether stem or root, is very important. He accepts Van Tieghem's definition of the stele as the solid cylinder of root or stem enclosed within the endodermis. The endodermis itself is considered as belonging to the cortex because in the root its cells are opposite the radial files of the inner cortex, and indeed form the inmost rank of these files; this is assumed to indicate a common origin by repeated tangential division. The cells of the pericycle, the outermost layer of the stele, alternate with those of the endodermis. As a rule there is no corresponding radial arrangement in the cortical tissue of the stem, but where such exists (as in the stem of Hippuris) the endodermis is again included in it and terminates it. Schoute in 1903 got precise results in species of Hyacinthus, Helianthus, and Linum, in the roots of which the periblem passed into the cortex, its inner layer becoming the endodermis, and the plerome gave rise to the stele only; but owing to difficulties arising chiefly from the insertion of leaves close up to the stem apex and displacements in the original stem structure owing to this habit, Schoute found definite results only in Hippuris, where the plerome gave rise not only to the stele but also to the endodermis and to the two or three inner layers of cortex immediately beyond it. If Schoute's results are well founded the limit between plerome and periblem does not correspond with that between stele and cortex in the stem of Hippuris, and doubt is also thrown on the assumption made by all previous observers that rows of cortical cells arranged in radial files must be of common origin.

The stelar hypothesis is essentially an assertion of the real homology between the vascular systems of stem and root throughout all vascular plants. No difficulty arises so long as we are dealing with roots only, or with the stems of those vascular Cryptogams in which the vascular system is a closed cylinder without gaps at the insertion of the leaf-traces: in such plants the vascular cylinder is as well defined as in all roots and can be described in the same terms. But the case is quite different in the stems of Phanerogams, where apparently the primary vascular cylinder is a system built up of leaf-traces embedded in a parenchymatous matrix. The early anatomists were faced at once by this problem in its crudest form, for they began with the primary structure of the dicotyledonous stem, and that of the root was not clearly understood until many years later; since they attempted to interpret it by reference to the skeleton of the stem and in the same terms; though there is nothing in the anatomy of the root to correspond with the leaf-trace, and the leaf-trace is the vascular unit of stem structure in all Phanerogams. Even when the facts of root structure were accurately known, the conception of the leaf-trace bundle as the structural unit continued to be a stumbling-block. Modern anatomy dates from 1871, when Van Tieghem published the first of his series of memoirs in which the axial core of the root was treated as equivalent to the whole system of leaf-traces in the stem; a conception which gained ground from the first, and was popularised by the happy choice of the term "stele" in 1886. From that time the stelar hypothesis has replaced all other schemes of vascular anatomy; the advance then made on all previous generalisations has been shown by the new impulse given to research and the comparative simplicity introduced into text-book anatomy, though equal simplicity cannot be claimed for the technical

language of research in this subject. It is generally accepted that the central cylinder of the root in Phanerogams is far more closely comparable to the leaf-trace cylinder of the stem than to any one of the traces within it, yet when the comparison becomes detailed difficulties arise. For instance, where there is a pith in the root it certainly forms part of the stele, which is a solid cylinder sharply defined by the specialised endodermis around it; but the leaf-traces in the young stem surround a massive cylinder of parenchyma exactly resembling the parenchyma of the cortex with which it is in apparent connection through the gaps between the leaf-traces. Even the secondary formations in the stem do not completely divide one system from the other; when a specialised endodermis is present it is not so clearly defined as in the root; in many cases it is not present, and in a few instances there is an endodermis around each leaf-trace. However, the stele in the stem of Phanerogams is not necessarily a morphological fiction, because in many stems its precise limits cannot be determined, for morphology is not merely descriptive. If we suppose that the stem stele in remote ancestors of the Phanerogams was as well defined as that of the root, and clearly comparable to it, we may attach a real morphological meaning to the term when applied to modern Phanerogams, provided we can show cause to believe that what we call the stele in their stems represents the ancestral stele. Its tissues will then have a history distinct from those of the cortex, though not clearly separated from them. The burden of proof, however, lies with those who assert that an apparently continuous and uniform tissue can be separated into two parts of distinct origin.

The evidence advanced is of two kinds—one founded on the comparative anatomy of stems and the other on the history of the tissues of the individual plant. Schoute has collected evidence to show that in the stems of Angiosperms a specialised layer is commonly distinguished from adjacent tissues either by the peculiar thickening characteristic of the endodermis in the root, or by the presence of starch in its cells. He shows that such a sheath surrounds the vascular cylinder in a very large proportion of Dicotyledons and in a majority of the Monocotyledons, while among Gymnosperms it occurs but rarely; and since the Angiosperms in which this bundle-sheath is obscure or wanting are commonly closely related to species in which it is perfectly well-defined he concludes that its absence in such cases must be attributed to reduction. Allowing that such a layer is as general among Angiosperms as Schoute believes, doubt may still exist as to its homology with the endodermis of the root, which is defined, not only by its thickened walls, but also by the fact that the cells form the inmost rank of the series of radial files distinguishing the inner cortex, while in the stem the inner cortex cells are very rarely arranged radially.

As regards the second class of evidence, that drawn from the history of the tissues in the individual plant, we have already seen that the differentiation of plerome from periblem is far less definite at the growing-point of the stem than at the root apex, and doubts have even been thrown on the identity of plerome and periblem with stele and cortex respectively. But we must now follow the development of the tissues of the embryo into those of the seedling. The normal seedling of all Phanerogams consists at first of cotyledons, hypocotyl, and root, the plumular bud being still rudimentary. The primary root lies usually in a straight line with the primary stem or hypocotyl. The hypocotyl is commonly the first part of the embryo to lengthen, and then its xylem is lignified a little earlier than that of the root or even of the cotyledon; but when, as in many Monocotyledons, the base of the cotyledon lengthens first, lignification begins in that region and advances through the hypocotyl to the primary root. The investigation of the anatomy of the seedling at this epoch becomes extremely important when the vascular system of the root is compared with that of the stem, for in the seedling we have a complete and simple vascular skeleton which at one end belongs to the primary root of the plant and at the other to its primary stem; hence there must be an intermediate region in which stem structure passes into root structure, and the method of transition should at least suggest, if it does not precisely determine, the relation in which they stand to one another. For this reason great value has been attached by anatomists to the transitional region of the main axis. Van Tieghem showed that there are several types of transition between root and stem, in all of which the xylem and phloëm bundles of the root are continued into the cotyledons or plumule; on their way through the hypocotyl they may divide or be displaced, and the xylem bundles "rotate" (that is, they turn on their axes until the protoxylem is internal), but all the elements present in the root are continued upwards in regular succession and are simply re-arranged in the upper part of the seedling. Hence Van Tieghem considered that the steles of root and stem are completely homologous. Gravis and others, however, consider that there is no morphological continuity in the hypocotyl between the vascular systems of root, stem, and leaf: their traces are merely in contact sufficiently intimate for physiological purposes, but there is no true homology between the central cylinder of the stem and that of the root. The third view is that of Chaveaud, who agrees with Gravis that the presence of external xylem is the rule in the hypocotyl and in the base of the cotyledon, but considers that this external xylem belongs to the primitive structure of hypocotyl and cotyledon as well as to that of the root.

As already stated, the vascular system of seedlings is first differentiated in the hypocotyl, base of cotyledon, and base of primary root. According to Chaveaud, in all these regions the primitive stele is root-like, the xylem alternating with the phloëm and its development being centripetal; but this primitive formation is permanent only in the root and commonly in the lower part of the hypocotyl also—in the upper part of the hypocotyl and in the base of the cotyledons the first xylem elements are fugitive and disappear so early that as a rule they are missed completely by the anatomist, who is apt to prefer well-differentiated material and therefore to choose seedlings which are past their first youth. Chaveaud therefore considers that there is an early phase in the development of the seedling in which the stele of the hypocotyl—at that time the only representative of the stem—is developing on exactly the same lines as the stele of the primary root, and is, in fact, continuous with it. At that epoch each cotyledonary trace is also developing on the same plan: it belongs to the same phase of evolution. In many Dicotyledons the insertion of the cotyledons is the simplest imaginable—the original stele of the hypocotyl divides below the cotyledonary node and one half goes to each cotyledon. Where this formation is clearly developed there cannot be said to be any transition between stem and root structure, since stem stele and root stele are continuous and their steles are developing in the same way, while even the leaf-traces of the first two leaves are on similar lines, and their insertion therefore does not modify the structure of the stele. The structure we associate with the stem of Phanerogams appears as follows. In the transitional region of the hypocotyl the first xylem elements—perhaps only two or three at each pole—alternate with the phloëm groups. The elements next differentiated lie within them, for development is still centripetal, but in two diverging groups. The xylem ray is then shaped like an inverted V. Each arm of the V approaches the adjacent phloëm group as it travels inwards, until the last-formed elements lie on the same radius as the centre of the phloëm group, but well within it. The next elements are differentiated on that radius, but are directed towards the phloëm—development has become centrifugal. These successive xylem formations are termed by Chaveaud the alternate, the intermediate, and the superposed. The alternate elements are fugitive in this transitional region: they commonly disappear as the superposed elements become conspicuous. The intermediate xylem persists; but higher up in the hypocotyl the intermediate elements also disappear as the seedling becomes older. Hence in seedlings of a certain age we have endarch bundles at the top of the hypocotyl, forming a stele of the stem type, and an exarch stele lower down, which passes unchanged into the root, the connection between the two being maintained by the intermediate xylem of the transitional region.

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Chaveaud believes the stem cylinder in the upper hypocotyl of a fairly old seedling to be a true stele, but one belonging to a later phase of evolution than that of the root, and not strictly homologous with it in the sense in which the earliest vascular formations in cotyledon and hypocotyl respectively were homologous with each other. He considers that the successive vascular formations — marked by the appearance of alternate, intermediate, and superposed xylem in turn — represent three successive phases of stelar development: the root stele corresponds with the first of these phases only. This implies the hypothesis that at some past period a group of plants in the direct line of descent of Angiosperms possessed a stele resembling that which is now a mere stage in the life of the individual; thus the alternate formation found throughout the very young seedling implies an ancestral group with an exarch stele in stem as well as root, and a leaf-trace of corresponding structure. If this view be adopted, the seedling must, during the period when it consists only of cotyledons, hypocotyl, and primary root, with the plumule present as a mere bud, represent a past period in race history when its ancestors possessed an exarch stele in both stem and root, when the stem stele belonged to the stem only and the insertion of leaf-traces hardly modified its structure, and when it entered the root without change, and therefore no transitional region occupied and puzzled the anatomist of the period! This early stage in the development of the seedling is succeeded by that in which the epicotyl (plumule axis) begins to grow, and as a rule the epicotyl is undoubtedly modern: its vascular skeleton is built up of leaf-traces which are endarch from the first, at the cotyledonary node they are inserted on the vascular cylinder of the hypocotyl which has become endarch at the top. This transition has been effected lower down in the hypocotyl, as described already, by the formation first of intermediate and then of superposed xylem together with the gradual disappearance of the original alternate xylem. Hence the cotyledonary node may be considered to mark the interval between two acts in the drama of evolution—an interval the length of which cannot yet be estimated, but is clearly to be reckoned in geological epochs. The race history of the phanerogamic stem-cylinder is at present unknown; possibly the development of the hypocotyl may give a clue as suggested by Chaveaud, or Jeffrey may be right in deriving the leaf-traces from a simple tubular stele (siphonostele) which has become more and more broken up by the appearance of foliar gaps. Until this point is cleared up the exact relationship of the vascular cylinder of the stem to that of the root will remain obscure; as a matter of convenience the stem cylinder will no doubt be called a stele, even should anatomists acknowledge that it cannot be considered as strictly homologous with the stele of the root, but much confusion of thought would be avoided if the two structures were not treated as strictly comparable.

Apart from the foregoing consideration of modern embryology in relation to a single problem of internal anatomy, namely, the comparison of the vascular system of the stem to that of the root, the evidence of embryology is of great weight in questions of internal morphology and phylogeny. Hanstein's account of the Monocotyledon embyro suggests two distinct problems: (1) whether a terminal member can be considered as a leaf, (2) whether Dicotyledons are derived from a monocotyledonous ancestor, or Monocotyledons from a dicotyledonous form. The most obvious interpretation of Hanstein's observations is that the single cotyledon of Monocotyledons is equivalent to the pair found in Dicotyledons: this would imply that Dicotyledons were derived from an ancestor with one cotyledon, apparently terminal, which gave rise to the existing pair by a process of splitting; but other interpretations are possible, and the terminal hypotheses received a shock when Solms-Laubach discovered that in certain Monocotyledons the single cotyledon is lateral from the first. The comparative antiquity of Monocotyledons and Dicotyledons has been one of the first questions raised by the study of seedling anatomy, and it is remarkable that both the hypotheses founded on work of this kind assert the greater antiquity of the dicotyledonous form; but if the cotyledonary member of Monocotyledons is derived from one or both cotyledons of an ancestral pair, it cannot be considered as terminal. Thus the evidence of seedling anatomy bids fair to settle both these problems, and probably others of the same kind.

Though the progress of botanical embryology has been here treated from the morphological side only, it is clear that every department of botany must deal with the immature plants as well as with the adult form. For instance, the struggle for existence between two species in any particular locality must be profoundly affected by the characters of their seedlings. If one species should gain a decided advantage over the other early in life, the vanquished species may never live to set seed, and may thus disappear from the neighbourhood in the first generation. This is an extreme case to show the importance of considering seedling structure in problems of ecology and distribution. The internal structure of seedlings is certainly a department of vegetable anatomy, just as their adaptation to the conditions of life is a department of vegetable physiology. That the connection between embryology and systematic botany must be equally close seems at first sight to be beyond dispute, but the exact nature of that connection is as yet undetermined. Certain features of the embryo are included among the characters used by systematists, but on the whole, the latter have dealt exclusively with the adult plant, the embryo itself having been treated rather as a portion of the seed than as an individual. We need not be surprised if conclusions drawn from the new embryology—that is, the embryology which includes internal characters as well as external—sometimes appear to conflict with the results of systematic botany, and it does not necessarily follow that embryological evidence is of no systematic value. The fault may lie with the embryologists who, being human, do occasionally misinterpret their facts, or possibly the natural system may need some modification in the light of new knowledge. When both explanations have failed to account for the discrepancy in a number of cases, we may be forced to give up looking for phylogenetic results from embryology.

A summary of various papers read at the Birmingham meeting will be given in these columns next month.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

PATHOGENIC ORGANISMS IN RIVER WATER.—Mr. A. C. Houston deals, in the *Ninth Research Report, Metropolitan Water Board*, with the question of the typhoid bacillus and its distribution. In a former *Report*, an outline of which was given in these columns, it was shown that under the ordinary conditions of storage and filtration the sewage micro-organisms in a polluted river water are so diluted that a very large volume of the water must be examined in order to detect a single typhoid bacillus. "Where then," as Mr. Houston asks, "is the typhoid bacillus?" and he supplies the answer in the following words: "The home of the typhoid bacillus is not so much in impure waters, or even in the crude sewage from a large community, as in the 'factories' of disease, as exemplified by the 'carrier' case."

In other words, there may be much less danger in the contamination of water by the sewage of a whole community than in traces of contamination from a single individual who happens to be what is known as a "typhoid carrier." In the case of the ordinary sewage contamination produced by a large town the effect of these unknown typhoid "carriers" is reduced by dilution, so that the water will probably contain only the normal quantity of typhoid bacilli. Incidentally it is pointed out that there is but little risk of typhoid infection from breathing sewer gas, and it is interesting to recall that this confirms the conclusion of a former editor of "KNOWLEDGE," Mr. A. C. Ranyard, who, twenty years ago, wrote an article on the subject in this journal.

Mr. Houston also calls attention to the striking differences between the death-rates from typhoid shown by European and American cities. This is illustrated by examples of which the following may be quoted :—

	Population.	Typhoid Death-Rate per 100,000.
Edinburgh	320,000	1·3
Berlin	2,000,000	2·2
London	7,280,000	3·3
Vienna	2,000,000	3·8
Paris	2,750,000	5·6
Boston	670,000	11·3
New York	4,766,883	11·6
Philadelphia	1,549,008	17·5
Washington	331,069	23·2
Minneapolis	301,408	58·7

In Mr. Houston's opinion the excessive prevalence of endemic typhoid fever in American cities is probably due to the "carrier" element, rather than to the consumption of impure water in the ordinary sense; since it can be shown by calculation that an ordinary glass of properly purified water will probably not contain a single typhoid bacillus.

CHEMISTRY AT THE BRITISH ASSOCIATION.—Twenty-seven years had passed since a meeting of the British Association had been held in Birmingham. It was at the former meeting in 1886 that Sir William Crookes suggested that the elements might have been evolved from a hypothetical primordial substance or Urthyl. It was therefore appropriate for the President of the Chemical Section, Dr. Wynne, to review the progress that has been made in this and other directions during the last quarter of a century.

With regard to the brilliant hypothesis of Sir William Crookes, the President pointed out that this common origin of all the elements was now commonly accepted, although "the question whether the term 'transmutation' is verifiable under available conditions is answered differently according to the view we take of the disintegration of radium and kindred phenomena."

The main portion of Dr. Wynne's address, however, was occupied with a discussion of the chemical change known as substitution from the point of view of Werner's conception of valency, according to which an atom may possess both a principal and an auxiliary or residual valency.

The reports of two committees were presented to the section, one dealing with "Dynamic Isomerism" and the other with "The Study of Plant Enzymes." In the latter an outline is given of the evidence in support of the view that the pigments in the sap of plants are produced by the oxidation of a colourless chromogen by means of an oxidising enzyme or oxydase.

Most of the papers read before the section were of a highly technical character, and implied a good knowledge of physical and organic chemistry on the part of the audience.

Of more general interest, however, were the communications upon radio-active elements. The investigations of Mr. Fleck during the last year have shown that of the eleven new radio-active elements studied all, with the exception of Uranium X, are chemically identical with common elements already known, such as lead, thallium, and thorium.

In Mr. Soddy's paper upon "The Radio-Elements and the Periodic Law" the conclusion is drawn that "in that part of the Periodic Table in which the evolution of the elements is still proceeding each place is seen to be occupied, not by one element, but on the average, for the places occupied at all, by no less than four, the atomic weights of which vary over as much as eight units. It is impossible to believe that the same may not be true of the rest of the table, and that each known element may be a group of non-separable elements occupying the same place, the atomic weight not being a real constant, but a mean value, of much less fundamental interest than has hitherto been supposed."

The communications dealing with applied chemistry included one upon "The Effect of Impurities on the Quality of Commercial Copper," by Mr. F. Johnson, and "The Action of an Alkaline Natural Water on Lead," by Messrs. Liverseege and Knapp, an outline of which will be given later.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

CORROSION OF CONDENSER TUBES.—The results of a long series of experiments carried out with the object of examining some of the factors which seemed likely to bear upon the nature and speed of corrosion in condenser tubes were communicated to the August meeting of the Institute of Metals by Dr. G. D. Bengough and Mr. R. M. Jones. Tubes of four standard compositions were immersed in stationary sea-water at different temperatures, and similar tubes were used in an experimental condenser plant. The results show that the temperature is a very important factor in determining both the nature of the chemical reäctions between sea-water and brass, and also the speed with which the brass is attacked. Action is much more rapid at higher temperatures and the experiments demonstrate the bad economy of overloading condensers. The authors made direct experiments to test the theory that particles of coke, and so on, deposited in the tubes give rise to local galvanic action, resulting in pittings, but could find no evidence of this action taking place. From their experiments they conclude that selective corrosion, resulting in dezincification and pitting, is an inherent property of the alloys examined. They consider that the Admiralty alloy, copper 70, zinc 29, tin 1, and Muntz's special brass, copper 70, zinc 28, lead 2, are more suitable for condenser tubes than plain brass composed of copper 70, zinc 30, and they recommend the extended use of electro-chemical protection.

THE CRITICAL POINTS OF STEEL.—A method of determining the critical points Ar 1 and Ac 1 without the use of a pyrometer is described by Dr. J. E. Stead in a paper read before the Iron and Steel Institute at the September meeting. Two bars of the steel are supported, without touching each other, in a short length of porcelain tube, which is then inserted in the side of a muffle furnace. The bars are allowed to remain until the temperature conditions become constant, the inner ends of the bars being at a temperature of about 1000° C., and the outer ends below 700° C. One bar is then withdrawn for about 15 mm., and the heating continued for about fifteen minutes more. Thin wires of pure silver, aluminium, zinc, and so on, are then inserted in the space between the bars, and the points on the bars where the wires just melt are ascertained. A scale can thus be plotted showing the temperature at each point along the bars. The bars are then withdrawn, quenched, cleaned, and etched, whereby the line of demarcation between the hard and soft portions becomes clearly visible. A reference to the scale gives the temperatures which the bars had at these planes when in the furnace. The withdrawn bar gives the Ar 1 point, and the other bar the Ac 1 point. The results obtained in this way are stated to be within 3° C. of the truth.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE DISTRIBUTION OF MAN.—The Presidential Address of Professor H. N. Dickson to Section E (Geography) of the British Association dealt with the question of the Redistribution of Mankind, and recently there has been published a good deal of matter bearing on the subject. The discussion of the problem is bound up with the discussion of resources, but there are certain questions of resources that are of necessity more or less indefinite and incapable of even probable solution. Such deal with coal supply, in general and

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in detail, and with the extent, position, and importance of supplies of metalliferous minerals. But a matter which is both fundamental and more definite is the supply of food.

Agriculture has presented to the man of limited capital who has energy and ambition and the desire to be his own master in a new country the most attractive if not the only prospect. The principles underlying his work are these: manual labour, which is scarce and costly, is the minimum; the crop covers a large area, so as to pay in spite of the low yield per acre; the ground opened up in the first year is sown and the three months which elapse before the crop comes to the harvest are occupied entirely in opening up fresh land for the next spring. We find Canadian and United States harvests give as low as twelve to fourteen bushels of wheat per acre, Australian (and Russian) eight to ten, compared with twenty-eight to thirty-two, twenty-seven to thirty-three, thirty to thirty-five for the United Kingdom, Holland, and Belgium respectively (J. F. Unstead, "The Statistical Study of Wheat," *Geographical Journal*, August, September, 1913.)

As the demand for wheat grows, the supply may be increased, either by increasing the amount of land under cultivation or by increasing the yield. In certain parts the amount of suitable land under cultivation has closely approached the limit of the amount available, and in any case there is a very definite and reasonably well-ascertained maximum of such land. In the United States this is already evident in its effects. (The American Transcontinental Excursion, 1912, I, "Economic Aspects," by G. G. Chisholm, *Geographical Journal*, October, 1913.) Intensive cultivation is being more and more widely practised, and from the Western States there is a steady stream of emigration to Canada, where the amount of unoccupied wheat land is greater.

It is on account of the great and rapid development of the means of sea and land transport that certain less crowded regions have been able to act as granaries for the thickly populated industrial areas, and this has led to a type of modern colonisation of a markedly recent and rapid growth. But the countries originally mainly agricultural are filling up with an industrial population as new resources are explored and opened up. The consequence is that home productions are more and more used at home, and the surplus for export diminishes. The mean percentage of the total production of wheat exported from the United States fell from thirty-two for the period 1881-90 to nineteen for 1901-10. Russia shows a corresponding fall from twenty-six to twenty-three; only newer countries—Canada, Australia, the Argentine—show large increases. Generally in a country the obvious resources are the first used and the first to reach maximum development, and among these are agricultural resources. Later developments lead to the growth of an industrial population. The order seems natural and inevitable, and Canada and the United States may be taken as types of the earlier and later stages in the evolution of a country.

Wheat is produced as a rule at a distance, often very great, from the industrial centres in which it is consumed, and the cost of transport forms an important if not large part of the cost of the food. The possibility of local production in any commodity depends on, among other things, the cost of the same commodity when imported, and the cost of the home product is simply the cost of production.* Import and local production tend therefore to a state of conditional equilibrium, and the condition may be represented by the formula due to Professor Dickson (*loc. cit.*), slightly modified:

$$I \rightleftarrows E + T,$$

where I represents cost of local production, E cost of production at a distant place, the cost of transport from which is represented by T. The state of true equilibrium is ideal, and there will always be an excess on one side of the equation representing the merchant's profit, and indicating whether imported goods or local products form the main supply.

Scientific statistical study is extremely important in Economic Geography. It should be more widely cultivated because it gives, as it were, a partial differential equation in which variation is expressed with respect to one variable and variation with respect to a complex of others is implicit, and to which a general solution can be found. The essential is that the study be scientific and rigid. Taking wheat in production and distribution as the variable, the solution gives these final results with regard to the redistribution of man: (*a*) intensive methods of cultivation will be adopted and lead to increase in manual labour, and consequently to increase in density of population in regions mainly agricultural and thinly populated at present; (*b*) cost of food will increase, and this will result in an alteration of equilibrium in remuneration for work of all kinds, and in increase of agriculture in countries now almost wholly industrial; (*c*) agricultural and industrial areas will be more closely intermingled, but there will be no less centralisation than at present, and nodal towns will tend to become huge in size.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

CALCAREOUS ALGAE AS ROCK-FORMERS.—This interesting but neglected subject was taken up by Professor E. J. Garwood in his Presidential Address to the Geological Section of the British Association. Whilst examining the Lower Carboniferous rocks of the North of England, Professor Garwood was impressed by the abundance of nodular structures at certain horizons, and the large areas over which these structures extended. Examined microscopically the nodules were found to be organic, and to consist largely of the calcareous alga known as *Solenopora*. This was the starting point of an investigation which proved calcareous algae to play a much more important part in the formation of limestone deposits than had hitherto been considered. It was also shown that certain forms became dominant over wide areas at the same geological period, and might be used as proof of the general contemporaneity of two deposits. As an example is cited the abundance of *Solenopora compacta* during Llandeilo-Caradoc times over an area covering the Baltic Provinces, the British Isles, and Canada. The presence of calcareous algae, which flourish best in the clear, shallow waters of bays and lagoons, also furnishes evidence as to the conditions prevailing during the accumulation of the rocks containing their fossil remains.

THE ENRICHMENT OF SULPHIDE ORES.—The principle of the secondary enrichment of sulphide ores, announced almost simultaneously and independently by S. F. Emmons, W. H. Weed, and C. R. Van Hise in 1900, has received much discussion in the intervening thirteen years, and has been made the subject of a bulky Bulletin (No. 529) of the United States Geological Survey, by W. H. Emmons. The principle is simple. Under the influence of atmospheric weathering sulphide ores break down and form soluble salts, chiefly sulphates. When conditions are favourable these acid solutions will be carried downwards, generally along the channels afforded by the fissured zone which contains the ore-body. The unoxidised rocks below the ground-water level are in general alkaline, and acid solutions encountering them in regions where air is excluded will lose acidity, and certain of the metals they contain will be precipitated. Also if the solutions of metallic sulphates encounter sulphides in depth, precipitation of metals may ensue; or there may be an interchange between the metals in solution as sulphates and the metallic sulphides. As a consequence of these reäctions certain parts of the ore-body

* Exception may be taken to the economics of the discussion. In the first place, a (more or less problematical) future position is considered up to and in which the nature of human (European) food continues as at present, and in which the questions of supply and demand are somewhat different. For simplicity the matter is taken as less complex than it really is: supply and demand at a price and changes in mode of living are ignored; the question of whether land is or is not available does not necessarily arise. The whole is to be thought of as giving the "differential equation" of the last paragraph.

FIGURE 505.
Chrysanthemum leucanthemum
with florets in the disc.
(See Page 409).

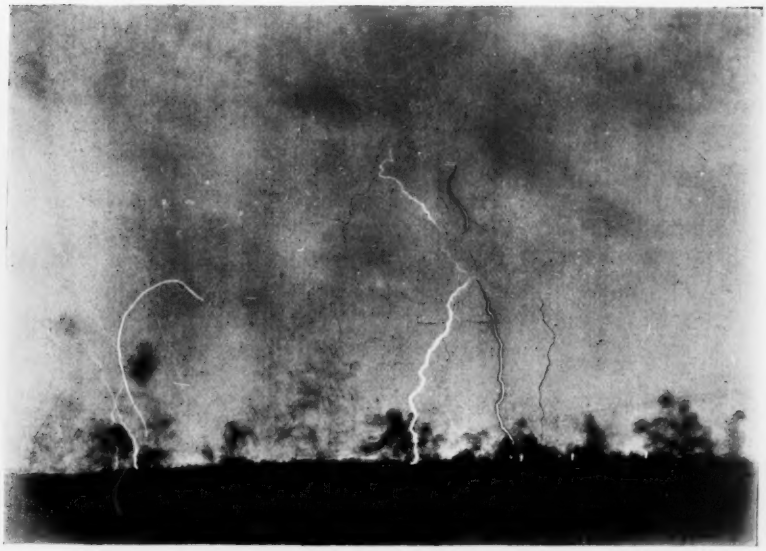

FIGURE 506. Three lightning flashes giving different images.
(See Page 439).

FIGURE 507. Lightning flashes taken at Johannesburg.

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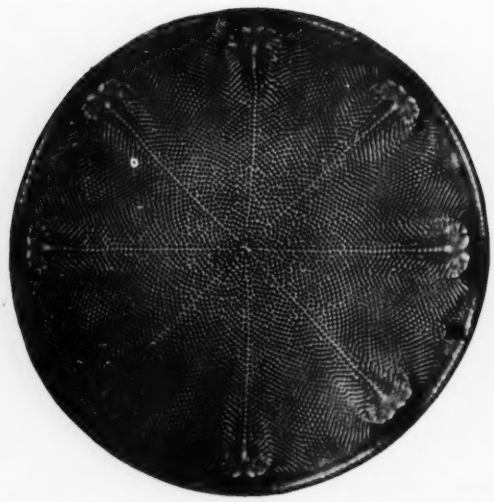

FIGURE 508. *Anlacodiscus kittonii*, eight rays. Objective used; Zeiss's B.B. of 0·30 N.A.; × 375.

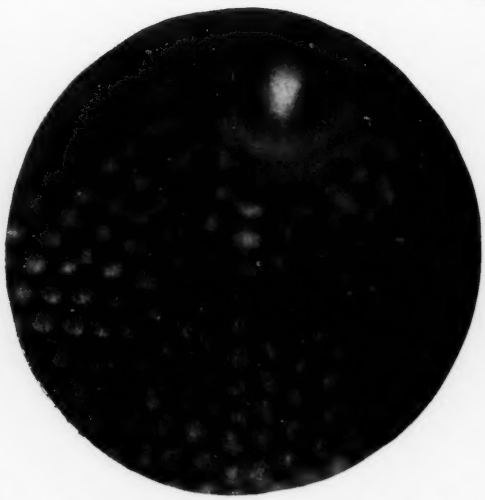

FIGURE 509. *Anlacodiscus sp.?*, a reproduction of Figure 411. Volume XXXV, page 372; × 1,900.

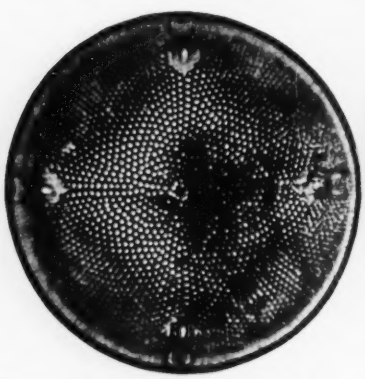

FIGURE 510. *Anlacodiscus sp.?*, from which Figure 509 was taken. Objective used; Zeiss's B.B. of 0·50 N.A.; × 375.

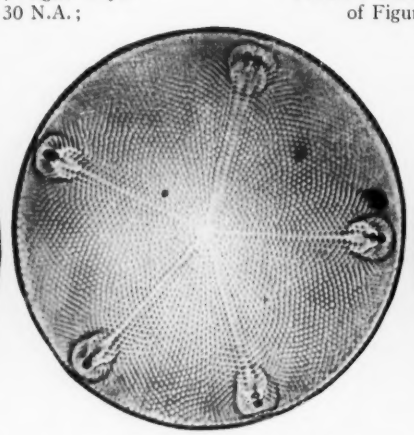

FIGURE 511. *Anlacodiscus kittonii*, from the west coast of Africa. Part of a group of four- and five-rayed forms.

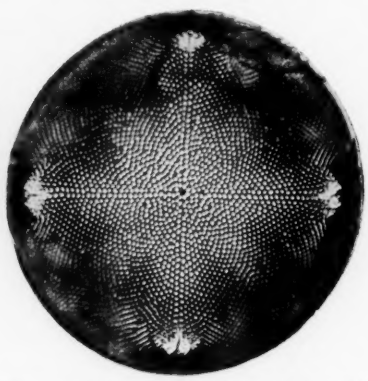

FIGURE 512. *Anlacodiscus kittonii*, four-rayed form. Magnification and objective the same as in Figure 510.

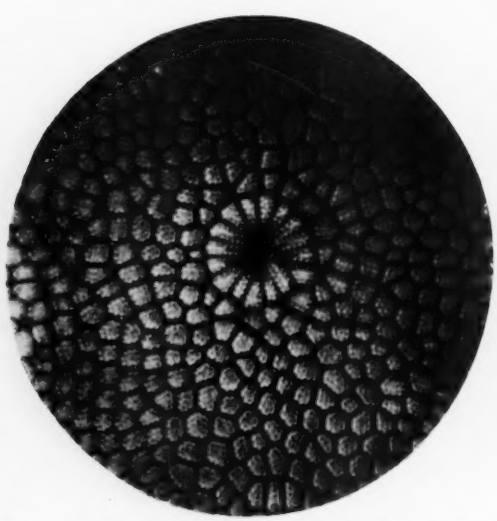

FIGURE 513. *Anlacodiscus kittonii*, centre of the valve, shewn in Figure 508; × 1900, the same lens used as in Figure 514.

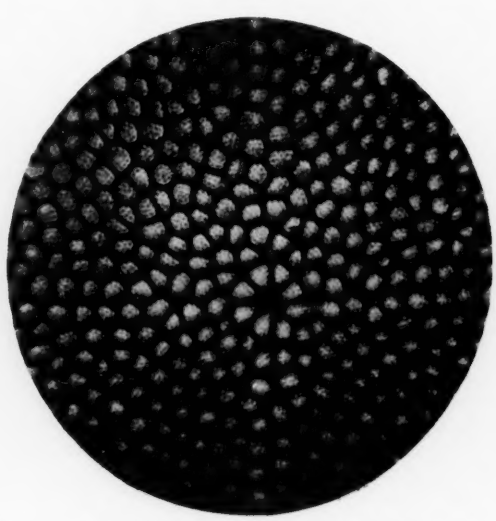

FIGURE 514. *Anlacodiscus kittonii*, centre of the valve, shewn in Figure 512. Objective used; Swift and Son's oil immersion of 1·30 N.A.; × 1,900.

are enriched. The greater part of the metallic contents of the upper portion of the ore-body which is being subjected to denudation is carried down in solution, and enriches the lower portion. Many ore-deposits, especially those of copper, are leached near the surface, and are considerably enriched below the leached zone. At still greater depths the ore becomes of lower grade. The zone of enrichment in a mining region is frequently found to have a clear relation to the surface topography, and especially to the ground-water level. The theory of sulphide enrichment has proved of considerable economic importance, and has been applied to many deposits of the metallic sulphides. The subject is of great interest to chemists as well as to geologists, as is shown by the lengthy chemical discussion in the above-mentioned bulletin.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

FISHERY RESEARCH AND METEOROLOGY.—In the *Annual Report on Sea Fisheries* for 1912, recently issued by the Board of Agriculture and Fisheries, reference is made to the scientific investigations carried out by the Board. It is stated that although hydrographic data have been collected systematically since 1903, it must be admitted that we are still only beginning to arrive at an understanding of the complicated inter-relations of physical conditions and abundance or dearth of fish. In many cases, however, it has already been possible to trace clear indications of a close connection, not only between hydrographical conditions and the movements of fish, but between these conditions and weather. There is a good reason to believe that changes in the ocean circulation, having a direct effect upon the weather, greatly influence the growth of trees, and the relation between atmospheric and hydrographic conditions is not without interest to the fishing community, both because of the effect of weather conditions upon actual fishing operations and because of wind pressure upon the currents of the sea. It is probable that meteorology has not yet been given its proper place among the numerous sciences which may contribute to the proper understanding of the problems connected with fishing.

THUNDERSTORMS IN EGYPT.—Mr. E. W. Bliss in the *Cairo Scientific Journal* for June gives some particulars about thunderstorms in Egypt. A list of all available records of thunderstorms for the forty-five years 1868 to 1912 was recently prepared by the Meteorological Service, and a summary made of the results. For the years 1868 to 1903 the records depend upon the observations made at Abbasia, but after 1903 they include four storms at Alexandria or elsewhere which escaped Cairo. The total number of days during the period on which thunderstorms, whether slight or severe, and also cases where lightning only was observed, was one hundred and eighty. The number of thunderstorms which were accompanied by hail or heavy rain, or did damage to buildings, was twenty-eight. It thus appears that there is an average of rather more than one thunderstorm in two years.

VOLCANIC DUST AND CLIMATIC CHANGES.—Professor W. J. Humphreys, of the United States Weather Bureau, in a paper just published in the *Bulletin of the Mount Weather Observatory*, has dealt with the subject of volcanic dust and other factors in the production of climatic changes and their possible relation to ice ages. Numerous attempts have been made to find a probable cause for the known climatic changes of the distant past, and especially for those profound climate changes that brought about the extensive glaciation that prevailed during the so-called ice ages; but nearly all the older suggestions have been definitely abandoned because they are inadequate to meet the conditions imposed upon them by the results of geological investigations. Professor Humphreys now puts forward the question of volcanic dust in the upper atmosphere as a factor in the production of climatic changes, including, possibly, even those great changes incident to the advance and retreat to maximum and minimum of glaciation. In his discussion of the subject he shows, among many other things, that volcanic dust in the high atmosphere decreases the intensity of solar radiation in the lower atmosphere, and therefore the average temperature of the earth; and this effect has been clearly traced back to 1750, or to the time of the earliest reliable records. It may consequently be said that such a relation between volcanic dust in the upper atmosphere and average temperatures of the lower atmosphere always has obtained, and therefore that volcanic dust must have been a factor, possibly a very important one, in the production of many, perhaps all, past climatic changes, and that through it, at least in part, the world is yet to know many another climatic change in an irregular but well-nigh endless series, usually slight, though always important; but occasionally it may be, as in the past, both profound and disastrous.

DAILY WEATHER MAPS FOR THE NORTHERN HEMISPHERE.—The Meteorological Committee in their Annual Report state that at the beginning of this year Mr. R. F. Stupart, Director of the Meteorological Service of Canada, brought to their notice specimens of the charts of barometric distribution over practically the whole of the Northern Hemisphere, which are prepared daily in Toronto by co-operation with the Weather Bureau of Washington. The charts in question differ from those now prepared in the Meteorological Office, ten days after date, for issue with the *Weekly Weather Report*, by including observations from Alaska. These are not charted on the Canadian Daily Chart, which is used for the compilation of the charts in the weekly report, but it is pointed out that they are of exceptional importance in relation to the general distribution of weather conditions.

The Meteorological Committee are informed that the Russian Government is raising the sum devoted to meteorology to £50,000 a year, with the object, among others, of initiating in the year 1915 a service of strictly simultaneous observations at 6 a.m. and 6 p.m. (Greenwich time) over the whole of the Russian Empire, which extends over nearly 180° of longitude. The extension of the ordinary daily working chart to include practically the whole of the Northern Hemisphere will then be easily realisable. At this moment the cable and wireless companies of the world could exchange information which would give a very fair representation of the weather conditions of the globe to those who are familiar with the average features. The realisation of the project of a "reseau mondial" for the daily weather service is now only a question of international organisation and of money.

MICROSCOPY.

By F.R.M.S.

ANLACODISCUS KITTONII—AN APOLOGY.—As author of the articles in "KNOWLEDGE" on "The True Structure of the Diatom Valve," the writer feels an apology is due from him to the editors and readers of this journal. It is due to them for his own lapse by making a claim which he now finds he cannot support, and begs to tender it accordingly. On page 372, Vol. XXXV, two photo-micrographs were represented by him as the first published of *Anlacodiscus kittonii*, showing the minute details of the structure under an oil-immersion objective of wide aperture. The statement in itself was true enough had the photographs but been of that diatom. Tricked, however, in his memory at the time, he now finds they were not, and his pretension falls to the ground.

The form then given is still probably a variety. It certainly is about the same size, has the same general features, plus the little bosses, but the cellules are much larger; neither does the secondary structure offer much difficulty in seeing or photographing. Such a situation renders the writer's position somewhat ridiculous, as he feels that he is bound to redeem his character somehow, and, after assuming the white sheet, now makes the attempt upon a form there can be no mistaking.

The photo-micrographs of the whole valves, taken for this article, are magnified three hundred and seventy-five times. Looking at the minuteness of the cellules in the two normal

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forms, even under this magnification, it will be seen at once how difficult is the task of photographing the still more minute secondary structure—six or more faint dots within each cellule. Nothing is more fitted to try the worker's mettle; indeed, one may say from one's experience in diatom structure, nothing else is so fitted. There still remains to try the mettle of the process worker and others in preparing the blocks.

The drawing of the finer structure of this diatom by Messrs. Nelson and Karop, published in *The Journal of the Quekett Club* for 1887, shows a few cellules only. Although professedly drawn to a scale of one thousand two hundred diameters, each cellule appears as of twice the size of those in the present prints, taken at one thousand nine hundred. One can question neither the good faith of the artist nor the real size of the details in the valve, yet the discrepancy can be easily accounted for by supposing that Mr. Karop found them almost impossible to make plain to the eye on so small a scale. This is the difficulty the present writer fears now in his own prints, though trusting to the skill of all connected with the production of "KNOWLEDGE."

In the drawing in question the six or seven dots within each cellule are rendered quite pale, a characteristic feature of this diatom, and one making them so difficult to photograph. The boundaries are formed by a series of similar dots, but black. One does not like to differ from such eminent observers as Messrs. Nelson and Karop, at the same time one cannot help feeling that they are due to interference from the under-structure of hexagons. Something of like appearance occurs in Figure 513 of the present article, yet on using the largest aperture of the substage condenser they disappear and the dotted membrane is seen to be continuous over the whole valve. There would be work for the owners of oil immersions during the winter months to solve this problem and then send the results to "KNOWLEDGE"—with the consent of the editors, of course. The evidence of a continuous membrane is not lacking in some of the coarser discoid forms. We have already seen that in *Triceratium favus* and *Coscinodiscus asteromphalus* there are structureless parts from which the kind of woven material forming the secondary structure springs. In one species of Coscinodiscus, however, from the Nottingham deposit, there is nothing of this; instead a uniform perforated membrane, stuck upon little bosses some distance above the hexagons, spreads over the whole valve.

Coming to the figures now, Figure 510 is of the same valve from which Figure 411 of the last article was taken at one thousand nine hundred diameters. Unfortunately the particulars underneath the print say two thousand seven hundred and fifty, but this is a mistake. In some manner the particulars of four hundred and ten and four hundred and eleven have become transposed. Figure 410 should read two thousand seven hundred and fifty diameters and 411 nineteen hundred. The next, Figure 512, is from an undoubted four-rayed normal form of *A. kittonii*, and it will be seen at once how minute are the cellules as compared with Figure 510. Figure 514, taken at one thousand nine hundred diameters from the centre of the same valve, shows the secondary structure, but so minute as almost to require another lens to see it. In Figure 509 we go back to Figure 411 of volume XXXV in order to compare the size of the cellules with Figure 514. The contrast between the two will then speak for itself.

Figure 508 is from an eight-rayed valve, a very beautiful variety. A photo-micrograph of the same variety of this species appears in the two editions of the Dallinger-Carpenter, taken at two hundred and seventy diameters, by Mr. E. M. Nelson, with an inch objective under dark-ground illumination. Seen on either the first or second plate it looks innocent enough, until one attempts the same performance with an inch objective. Believe one who has tried, and must confess to a dismal failure or failures in consequence. Figure 513 is from the centre of Figure 508, which, with Figure 514, the writer hopes may be taken as a fitting supplement to Mr. Nelson's print. He hopes also that he has now made his *amende honorable*, as really having done what he only boasted of doing before.

The varieties of *A. kittonii* range from three rays to nine. The centre valve in Figure 511 is a five-rayed form, and is curious otherwise as showing that Nature's freaks, such as Two-headed Nightingales and Siamese Twins, are not confined to complex organisms. At the end of each process in the normal form, under high powers, a little bulb of crystal can be seen, in shape like those used to light the carriages in the tube railways. They are just indicated in the print, but at the end of one process two appear in place of the usual one. The specimens in this mount are from the west coast of Africa. Ten in number consist of the four-rayed forms, one of five, yet the secondary structure is so minute as not to offer the slightest signs of resolution under an aperture of 1·30 N.A. Notice also the different shape of the processes from Figures 512 and 508.

PHOTOGRAPHY.

By EDGAR SENIOR.

GLAZING SILVER PRINTS.—When it is desired to impart a high degree of glaze to P.O.P. or bromide prints whcih are made upon a glazed surface paper, the prints after washing should be placed in a solution of some hardening substance, such as ordinary alum, chrome alum, or formalin. Especially in warm weather is this treatment necessary, since the gelatine surface often becomes very soft and liable to adhere to the surface used for squeegeeing upon, whatever precautions may have been taken to avoid it. If alum is employed as the hardening agent a five per cent solution should be employed; formalin, however, is to be preferred in many respects, as alum is not always successful in its action. The strength of the formalin solution should be about one ounce to ten or twenty ounces of water, and the prints should be allowed to remain in for five or ten minutes and then washed in several changes of water. With regard to the materials to be used for squeezing the prints upon, these may be either glass, ferrotype plates, or celluloid, the latter two being the least likely to give trouble from the prints sticking. If glass be used it requires to be very thoroughly cleaned, and must be soaked for some hours in either of the following:—

Nitric acid	5 ounces
Water	20 „

or

Potassium bichromate ...	1 ounce
Water	30 ounces
Sulphuric acid	1 ounce

The bichromate should be dissolved and the solution made perfectly cold before the sulphuric acid is added, this latter being introduced very gradually, stirring well all the time. As this mixture is very corrosive, great care is required in handling it. After the glass plates have been soaked for several hours, they should be well washed in water and allowed to dry, when they are polished with French chalk, this being dusted on to the plate and well rubbed over and finally dusted off again. Or in place of the French chalk a solution of beeswax in benzol or turpentine may be applied with a piece of rag or a tuft of cotton-wool, and the surface afterwards polished with a clean cloth. The following formula will give a good solution for the purpose:—

Beeswax	15 grains
Turpentine	1 ounce

The clean glass, ferrotype plate, or celluloid should have a little of this well rubbed over the surface and then polished off. The material being ready, the prints are taken from the washing water and laid face downwards, and then squeegeed into contact and allowed to become thoroughly dry before any attempt is made to strip them, and on no account must the drying be at all accelerated by heat, or the prints will be difficult to remove from the support. Sometimes difficulty is experienced in getting them off, but this can be prevented by drying the prints first and then rewetting them; and if care be taken to have the surface of the material thoroughly well cleaned and prepared the prints should almost leave by themselves, especially so when ferrotype plates are used.

PHYSICS.

By ALFRED C. EGERTON, B.Sc.

A SENSITIVE PRESSURE GAUGE.—M. Guéritot publishes in the *Comptes Rendus* for June, 1913, an account of a sensitive manoscope which employs thermo-electric junctions to detect very small displacements of air. Two vessels are connected by a tube which is bent in the middle upwards; the tube is heated at the point of the bend electrically, and the heated air remains in the neighbourhood of the bend. On each side of the heated portion of this tube are inserted two junctions of dissimilar metals connected to a galvanometer. Any displacement of the heated air causes a difference of temperature between the two thermal junctions, and consequently an electromotive force is set up which drives a current through a galvanometer. Very small displacements of the heated air can be measured; in fact, variation of atmospheric pressure by one millionth of a millimetre of mercury can be detected.

NEON AND X_3.—Among the most interesting announcements at the Birmingham meeting of the British Association may be mentioned the experiments of F. W. Aston on the separation of neon by diffusion into two constituents possessing atomic weights very nearly the same, confirming in a remarkable way the positive-ray experiments of Sir J. J. Thomson, which showed that neon should contain two substances of very nearly the same atomic weight. The other announcement was by Sir J. J. Thomson about the supposed new gas, X_3. The atoms of a gas of atomic weight 3 had been identified by his positive-ray method. The properties of this gas have been recently studied by Sir J. J. Thomson, and he was able to announce that it behaved as a gas with a molecule consisting of three hydrogen atoms. Thus hydrogen, as well as oxygen, can give rise, under the action of electric discharge, to a molecule consisting of three atoms. The molecule of active nitrogen, discovered by Strutt, on the other hand, is supposed to consist of single atoms.

Section A of the British Association at Birmingham showed great activity, amongst the most interesting of the discussions being that on "Radiation."

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

POISON OF AMPHIBIAN SKIN.—It is well known that the defenceless Amphibians—toads, frogs, newts, salamanders, and the like—are protected by a poisonous secretion formed by skin glands. The phrynin of the toad has been often experimented with, and is a powerful poison. Madame Phisalix has recently found that injections of a modification of Amphibian poison will immunise an animal, *e.g.*, rabbit or guinea-pig, against a strong dose of the same poison. This is what might have been expected from analogous cases. But the further point is of much interest—that animals immunised against Amphibian poison are also immunised against the poison of the viper.

BEHAVIOUR OF FAIRY SHRIMPS.—Professor A. S. Pearse, of the University of Wisconsin, has made an interesting study of the behaviour of *Eubranchipus dadayi*, one of the fairy shrimps. Its movements are exceedingly easy and graceful. The body glides through the water slowly but steadily at the rate of about a foot in ten seconds, with the ventral surface usually uppermost or towards the light. There is considerable dimorphism between the sexes and a difference in colour that is of considerable interest. The males have a delicate, translucent, almost transparent, creamy colour, with reddish tail-pieces, while the females are reddish throughout. The transparency of the males enables them to wander about with comparatively little danger of being seen, and they are thus able to seek out and fertilise the females. On the other hand the coloration of the females makes them inconspicuous as they rest quietly in holes at the bottom of the pool, or await a mate at the surface in the shadow of some floating stick or other shelter. Professor Pearse's point is that "the coloration of each sex is apparently adjusted to its behaviour in such a way that it is well protected." The males have a strong sexual appetite, but as soon as a female has been provided with sperm she resists the advances of males, goes to the bottom of the pond in which she lives, and remains quiescent so that the eggs may descend into the ventral part of her ovisac, undergo fertilisation, and develop.

RACES OF SARDINE.—Louis Fage has made a study of the growth of the Sardine or Pilchard (*Clupea pilchardus*), using the method, now so much employed, of reading the age from the scales and otoliths. As in other cases, the concentric striated zones seen on a scale are interrupted by several clear non-striated zones, the latter indicating periods of rest ("winter rings"). As Hjort has said, "the growth of the scales is so closely bound up with that of the individual that it is possible by simple measurements of the zones of growth on the scale to retrace with real precision the history of the growth of the fish." The results of his measurements lead Fage to conclude that there are two distinct "biological races"—the Mediterranean and the oceanic Sardine. The former grows more slowly, and lags more and more behind as it grows older. He proposes to study the structural differences associated with this different rate of growth.

SIGNALLING AMONG TERMITES.—Professor E. Bugnion, of Lausanne (*MT. Schweiz. Entomolog. Gesellschaft*, XIII, 1913, page 125) communicates some very interesting observations on signalling among Termites. The phenomenon has been previously studied by König, Smeathman, Haviland, Sjöstedt, and Escherich, but Bugnion has gone further. Helped by H. von Buttel-Reepen, he found that the noise is produced by the soldiers, who knock on dry leaves or the like with their mandibles, or with the basal piece of the labium, which is exaggerated and hard. A cobra-like hissing, as it seemed at first, was traced to a colony of *Termes obscuriceps* which had formed its galleries on the big fallen leaves of the Bread Tree (*Artocarpus*). From a colony in Bugnion's office-desk answers used to be got to outside taps. In another experiment a piece of termitary was placed on a big plate and covered with stiff paper; the soldiers collected on the under surface of the paper and answered back to every vibration. The noise differs in different species, but is always due to minute blows on a resonating surface. The result may be a rustling, or a rattling, or a crackling, or otherwise. In the Indian *Termes estherae* Desneux, which turns out to be the same as König's *Hodotermes convulsionarius*, the noise made by the large and aggressive workers when they are disturbed is like the crackling of withered leaves trodden underfoot. There is evidence that the noises or the associated vibrations serve to warn the workers or to reassure and encourage them. There seems little doubt that they are of the nature of signals. That sounds or vibrations are really perceived is made clear by what was seen in the field, by the responses given by the tenants of Bugnion's desk to taps from without, and by the anatomical demonstration of a well-innervated sensory organ, which is probably particularly sensitive to the vibrations of a material like the framework of a leaf or branch, the wooden partitions of the termitary, the dry walls of the fungus-growing labyrinths, and so on. It is too soon to ask how much is auditory and how much finely tactile. The audible signalling is to be distinguished from another kind of signalling—a soundless signalling—which seems to be common among Termites. It is curiously like and unlike military saluting; for it seems that the soldiers salute the workers. So far as we know, both soldiers and workers are sexually immature individuals of both sexes. But this requires looking into. In the soundless signalling the insect stands firmly on its legs, with the head raised and the body slightly oblique, and shakes itself for an instant with a convulsive shiver. This seems to mean something to the passing worker. We cannot get psychologically near enough to say more.

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THE FACE OF THE SKY FOR DECEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 82.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
Dec. 1	16 27·9	S. 21·8	19 38·6	S. 25·9	15 24·2	S. 16·0	15 17·1	S. 17·0	7 47·3	N. 23·8	19 20·1	S. 22·5	4 56·4	N. 20·9	7 59·9	N. 20·1
,, 6	16 49·6	22·5	23 34·8	S. 2·4	15 28·4	16·2	15 42·5	18·7	7 45·3	24·1	19 24·6	22·4	4 54·6	20·9	7 59·6	20·2
,, 11	17 11·6	23·0	3 19·9	N. 23·0	15 44·9	17·5	16 8·4	20·2	7 41·8	24·5	19 29·1	22·2	4 52·9	20·8	7 59·2	20·2
,, 16	17 33·6	23·3	8 11·9	N. 23·9	16 8·5	19·3	16 34·8	21·4	7 36·8	24·9	19 33·8	22·0	4 51·1	20·8	7 58·7	20·2
,, 21	17 55·8	23·4	12 33·1	S. 5·6	16 36·1	21·0	17 1·6	22·3	7 30·5	25·3	19 38·6	21·9	4 49·4	20·7	7 58·2	20·2
,, 26	18 18·0	23·4	17 14·7	S. 28·1	17 6·3	22·5	17 28·7	23·0	7 23·0	25·8	19 43·4	21·7	4 47·8	20·7	7 57·7	20·2
,, 31	18 40·2	S. 23·1	21 52·2	S. 15·0	17 38·2	S. 23·6	17 56·0	S. 23·4	7 14·6	N. 26·2	19 48·3	S. 21·5	4 46·3	N. 20·7	7 57·2	N. 20·3

TABLE 83.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Dec. 1	+16·2	+0·7	277·0	− 8·8	−12·0	+9·7	98·1	5 17 *m*	− 9·3	−1·3	345·2	113·1	10 1 *e*	8 53 *m*
,, 6	14·2	+0·1	211·1	−21·8	12·3	9·3	53·0	8 23 *m*	9·7	1·3	62·4	143·2	10 18 *m*	5 59 *e*
,, 11	12·0	−0·5	145·3	−14·2	12·8	8·7	8·2	11 26 *m*	10·2	1·2	130·6	173·3	8 26 *m*	7 13 *m*
,, 16	9·8	1·2	79·4	+11·5	13·4	8·1	323·7	2 29 *e*	10·6	1·2	198·8	203·4	4 25 *e*	4 19 *e*
,, 21	7·4	1·8	13·5	+21·8	14·3	7·3	279·5	5 30 *e*	−11·1	1·2	267·0	233·4	4 42 *m*	3 30 *e*
,, 26	5·0	2·4	307·7	+ 4·5	15·3	6·4	235·5	8 30 *e*						
,, 31	+ 2·6	−3·0	241·8	−18·4	−16·4	+5·5	191·7	11 30 *e*						

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zones; T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

The asterisk indicates the day following that given in the date column.

THE SUN reaches its greatest South Declination (Winter Solstice) December $22^d\ 10\frac{1}{2}^h$ *m*. Its semi-diameter increases from 16′ 15″ to 16′ 17½″. Sunrise changes from $7^h\ 46^m$ to $8^h\ 8^m$; sunset from $3^h\ 52^m$ to $3^h\ 58^m$.

MERCURY is an evening star; reaches elongation, 21° W., on 10th, 1½° N. of Venus, $2^d\ 8^h$ *e*. Semi-diameter diminishes from 4″ to 2½″. Fraction of disc illuminated increases from ¼ to $\frac{11}{12}$.

VENUS is a morning star, but getting too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″.

THE MOON.—First Quarter $5^d\ 2^h\ 59^m$ *e*; Full $13^d\ 3^h\ 0^m$ *e*; Last Quarter $20^d\ 4^h\ 16^m$ *e*. New $27^d\ 2^h\ 59^m$ *e*. Apogee $6^d\ 11^h$ *e*. Perigee $21^d\ 2^h$ *e*, semi-diameter 14′ 48″, 16′ 10″ respectively. Maximum Librations, 1^d 6° W, 13^d 5° E, 13^d 6° S., 26^d 6° N, 28^d 5° W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 85.)

MARS rapidly approaches opposition. Nearest Earth on January 1st, distance 0·622. This is an unfavourable opposition as regards distance, but favourable as regards planet's declination. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during December increases from 6½″ to 7½″. The unilluminated lune is on the West: its width diminishes from ⅜″ to 0.

JUPITER is an evening star, but almost invisible. Polar semi-diameter, 15½″.

TABLE 84.

Day.	West.		East.		Day.	West.		East.	
Dec. 1	21	○	43		Dec. 13	31	○	24	
,, 2		○	4123		,, 14	32	○	14	
,, 3	4	○	23	1●	,, 15	21	○	34	
,, 4	4231	○			,, 16		○	2134	
,, 5	43	○	1	2●	,, 17	1	○	234	
,, 6	431	○	2		,, 18	23	○	14	
,, 7	423	○	1		,, 19	32	⊙		1●
,, 8	421	○	3		,, 20	341	○	2	
,, 9	4	○	123		,, 21	43	⊙	1	
,, 10	41	○	23		,, 22	421	○	3	
,, 11	23	⊙	4		,, 23	4	○	213	
,, 12	32	○	14		,, 24	41	○	23	

Configuration at 5^h *e* for an inverting telescope.

Satellite phenomena visible at Greenwich, $2^d\ 6^h\ 27^m$ IV. Tr. I.; $3^d\ 4^h\ 54^m$ I. Oc. D.; $4^d\ 4^h\ 32^m$ I. Tr. E.; $5^h\ 20^m$ I. Sh. E.; $11^d\ 4^h\ 15^m$ I. Tr. I., $4^h\ 56^m$ I. Sh. I.; $12^d\ 4^h\ 22^m\ 15^s$ I. Ec. R.; $14^d\ 4^h\ 44^m$ II. Sh. E.; $18^d\ 4^h\ 30^m$ III. Tr. E.; $21^d\ 4^h\ 26^m$ II. Sh. I. These are all in the evening hours. The reappearance from eclipse takes place on the east of the disc, to the right in an inverting telescope.

TABLE 85. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Mean Time.	Angle from N. to E.
1913.			h. m.		h. m.	
Dec. 5 ...	h^1 Aquarii	5·4	3 4 *e*	114°	3 44 *e*	176°
,, 8 ...	BD+ 9°142	7·1	5 42 *e*	105	—	—
,, 10 ...	BD+18°347	6·9	4 55 *e*	131	—	—
,, 10 ...	BD+19°432	7·0	9 7 *e*	56	—	—
,, 10 ...	47 Arietis	5·8	11 49 *e*	140	0 15* *m*	181
,, 11 ...	9 Tauri	6·7	3 50 *e*	87	—	—
,, 11 ...	16 Tauri	5·4	8 15 *e*	14	9 2 *e*	299
,, 11 ...	17 Tauri	3·8	7 53 *e*	59	9 8 *e*	254
,, 11 ...	20 Tauri	4·1	8 47 *e*	22	9 41 *e*	293
,, 11 ...	23 Tauri	4·3	8 57 *e*	144	9 16 *e*	173
,, 11 ...	24 Tauri	6·8	9 20 *e*	113	—	—
,, 11 ...	BD+23°540	7·0	9 24 *e*	74	—	—
,, 11 ...	η Tauri	3·0	9 29 *e*	121	10 18 *e*	198
,, 11 ...	BAC 1171	6·6	9 59 *e*	82	—	—
,, 13 ...	BAC 1746	6·5	5 56 *e*	80	6 54 *e*	259
,, 14 ...	BAC 1848	5·6	1 19 *m*	99	2 33 *m*	269
,, 14 ...	BAC 1918	6·1	6 11 *m*	128	6 58 *m*	248
,, 14 ...	BD+27°1164	6·9	—	—	6 53 *e*	263
,, 14 ...	BD+27°1194	7·7	—	—	8 42 *e*	194
,, 16 ...	γ Cancri	4·8	9 38 *e*	45	10 11 *e*	343
,, 17 ...	BD+20°2232	6·9	—	—	4 10 *m*	208
,, 17 ...	8 Leonis	5·9	8 57 *e*	76	9 45 *e*	320
,, 20 ...	82 Leonis	6·7	—	—	0 33 *m*	323
,, 20 ...	83 Leonis	6·3	0 20 *m*	122	1 21 *m*	299
,, 20 ...	τ Leonis	5·2	0 55 *m*	121	1 58 *m*	303
,, 21 ...	BAC 4172	6·6	—	—	5 21 *m*	279
,, 22 ...	BD−10°3635	6·9	—	—	5 24 *m*	326
,, 31 ...	ι Aquarii	4·4	5 45 *e*	359	6 24 *e*	291

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

The asterisk indicates the day following that given in the date column. Attention is called to the occultation of the Pleiades, on Dec. 11th, the Moon being 2 days before Full.

SATURN is very well placed for observation, being in opposition on the 7th. Polar semi-diameter 9½″. P. is −4°·4; B−26°·4. Ring major axis 48″, minor 21″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap.

East Elongations of Tethys (every fourth given), $1^d\ 10^h{\cdot}1m$, $8^d\ 11^h{\cdot}2e$, $16^d\ 0^h{\cdot}4e$, $24^d\ 1^h{\cdot}5m$, $31^d\ 2^h{\cdot}7e$; Dione (every third given), $6^d\ 6^h{\cdot}2m$, $14^d\ 11^h{\cdot}1m$, $22^d\ 4^h{\cdot}1e$, $30^d\ 9^h{\cdot}1e$; Rhea (every second given), $6^d\ 0^h{\cdot}9m$, $15^d\ 1^h{\cdot}5m$, $24^d\ 2^h{\cdot}2m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $2^d\ 11^h{\cdot}8m$ E.; $7^d\ 1^h{\cdot}7m$ I., $12^d\ 9^h{\cdot}8e$ W., $18^d\ 10^h{\cdot}3e$ S., $23^d\ 4^h{\cdot}1e$ E., $28^d\ 6^h{\cdot}2m$ I.; Iapetus, $17^d\ 9^h{\cdot}1m$ E.

URANUS is an evening star, but badly placed.

NEPTUNE is a morning star, in Cancer.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Nov. 25 to Dec. 12	189°	+ 73°	Rather swift.
Dec. 4 ...	162	+ 58	Swift, streaks.
,, 6 ...	80	+ 23	Slow, bright.
,, 8 ...	145	+ 7	Swift, streaks.
,, 8 ..	208	+ 71	Rather swift.
,, 10-12 ...	108	+ 33	Swift, short, conspicuous.
,, 12 ...	119	+ 29	Rather swift.
,, 22 ...	194	+ 67	Swift streaks.
,, 21-22 ...	117	+ 47	Swift.
,, 31 ...	92	+ 57	Slow, bright.

WESTPHAL'S COMET.—The following ephemeris covers the whole time over which the comet is likely to be visible with ordinary telescopes: it is likely to be a faint naked-eye object in November. The ephemeris is for midnight on the dates named.

Date.	R. A. H.	R. A. M.	R. A. S.	N. Dec. °	N. Dec. ′	Log. Dist. from Sun.	Log Dist. from Earth.
Oct. 20 ...	20	53	39	17	4	0·1358	9·8141
,, 24 ...	20	47	24	19	53	0·1287	9·8271
,, 28 ...	20	42	27	22	30	0·1225	9·8409
Nov. 1 ...	20	38	30	24	56	0·1169	9·8547
,, 5 ..	20	35	26	27	22	0·1119	9·8682
,, 9 ...	20	33	24	29	40	0·1075	9·8809
,, 13 ...	20	32	8	31	53	0·1038	9·8932
,, 17 ...	20	31	51	34	8	0·1014	9·9050
,, 21 ...	20	32	28	36	20	0·1004	9·9163
,, 25 ...	20	33	54	38	25	0·1000	9·9266
,, 29 ..	20	35	56	40	27	0·1004	9·9361
Dec. 3 ...	20	38	16	42	33	0·1011	9·9444
,, 7 ...	20	41	24	44	41	0·1028	9·9519
,, 11 ...	20	45	52	46	49	0·1062	9·9594
,, 15 ...	20	51	8	49	0	0·1103	9·9662
,, 19 ...	20	57	32	51	9	0·1149	9·9727
,, 23 ...	21	5	4	53	21	0·1206	9·9786
,, 27 ..	21	14	0	55	38	0·1268	9·9847
,, 31 ...	21	24	48	57	50	0·1332	9·9907
Jan. 4 ...	21	37	0	60	17	0·1402	9·9964
,, 8 ...	21	52	8	62	29	0·1483	0·0026
,, 12 ..	22	9	56	64	44	0·1565	0·0087
,, 16 ...	22	31	28	66	59	0·1652	0·0154
,, 20 ..	22	55	16	68	57	0·1740	0·0231
,, 24 ...	23	29	0	70	37	0·1826	0·0315
,, 28 ...	0	5	56	72	12	0·1918	0·0400
Feb. 1 ...	0	48	36	73	14	0·2012	0·0500

The path lies through Vulpecula, Cygnus, Cepheus, and Cassiopeia.

XUM

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—

TABLE 86. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Arietis	2 11	+24 ·7	7·5 to 12·7	186·66	Sep. 12.
R Ceti	2 22	− 0 ·6	7·5 to 12·8	166·88	Oct. 20.
U Ceti...	2 30	−13 ·5	6·6 to 12·7	235·2	Dec. 8.
R Trianguli	2 32	+33 ·9	5.9 to 11·1	265·4	Dec. 27.
Y Persei	3 22	+43 ·9	8·2 to 10·4	254·9	Nov. 2.
R Tauri	4 24	+10 ·0	7·4 to 13·8	325	Dec. 10.
X Camelop.	4 35	+75 ·0	7·5 to 13	141·5	Nov. 18.
T Leporis	5 1	−22 ·0	7·7 to 8·9	366·5	Dec. 6.
S Camelop.	5 32	+68 ·7	7·8 to 10·8	330	Dec. 20.

Principal Minima of β Lyrae Dec. $4^d\ 1^h e$, $17^d\ 11^h m$, $30^d\ 9^h m$. Period $12^d\ 21^h \cdot 8$.

Algol minima Dec. $3^d\ 6^h\ 18^m e$, $6^d\ 3^h\ 7^m e$, $15^d\ 5^h\ 34^m m$, $18^d\ 2^h\ 23^m m$, $20^d\ 11^h\ 11^m e$, $23^d\ 8^h\ 0^m e$, $26^d\ 4^h\ 49^m e$. Period $2^d\ 20^h \cdot 8$.

SOLAR DISTURBANCES DURING SEPTEMBER, 1913.

By FRANK C. DENNETT.

SEPTEMBER has yielded very little appearance of activity upon the Sun to the ordinary telescopic observer, although to the spectroscopist there does seem to be some increase. No observations were made on two days during the month (1st and 5th), spots were recorded on six days (6th to 10th and 16th), and faculae on nine others (3rd, 14th, and 24th till 30th). On the remaining thirteen days the disc appeared clear. On September 1st the Central Meridian was 37° 27′ at noon.

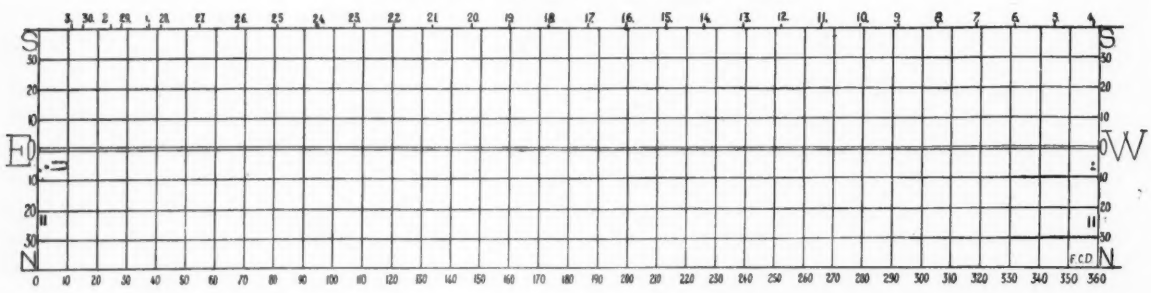
No. 11.—So late as 10 a.m. on September 6th the disc was reported clear, but at 1.20 p.m. a small irregular penumbraless spot was recorded. On the 7th it had four or five smaller companions, some bridged over, hydrogen flocculi were lying about the area, causing displacements of the C-line, first to red and later to violet. On the 8th the leading spot had increased somewhat, and a trailer spot with small companions had developed. Prominences were seen in projection over the group, as well as dark hydrogen flocculi. On the 9th only some members of the leading group visible, edged with brightness, and on the 10th, at 8 a.m., just one pore was left amidst the group of faculae which marked the area; but it was gone by midday. The group reached a length of 45,000 miles on the 8th. The dark line of helium, D_3, was traceable over this disturbance on the 7th, 8th, and 10th.

On the 16th, at 8 a.m., there appeared to be traces of pores on several parts of the disc, the largest being in South latitude some two days past the central meridian, and therefore near longitude 227°.

Faculae were seen near the eastern limb, well to the north, on the 3rd; on the 7th a small facula near longitude 258° and 60° N. latitude; on the 14th several bright flecks appeared scattered over the disc. Faculic flecks were persistently visible in the region within 20° of the north pole, records being made on the 24th and 27th to 30th; a faculic region over, and just ahead of, the area of No. 11, within the eastern limb, seen from the 25th until the 27th.

The observers whose work has contributed to this note have been Messrs. J. McHarg, A. A. Buss, C. Frooms, E. E. Peacock, and the writer.

DAY OF SEPTEMBER, 1913



CORRESPONDENCE.

LIGHTNING FLASHES.

To the Editors of "KNOWLEDGE."

SIRS,—During the evening of Tuesday, December 5th, 1911, a most vigorous but short-lived thunderstorm developed some distance to the north-west of Johannesburg. The flashes of lightning, which were principally cloud-earth discharges, were very brilliant, and followed one another at short intervals. I

had a whole-plate Sanderson camera practically ready for action, and set this up on the stoep of my house (facing northwards) as quickly as possible. As I had a focal-plane back on the camera, I opened the slit to the width of the plate and decided to expose by withdrawing the slide of the plate-holder, the lens cap not being at hand. Generally in photographing lightning one has to wait for a little time to secure a good flash, but on this occasion there were a number of bright flashes whilst I was in the act of withdrawing the slide. The bright flash to the right of the centre of Figure 507 was the first to occur. At the moment I was not certain whether the flash was too early for me. It was followed almost immediately by the great flash which appears on the left of the picture, and on seeing this I closed the plate-holder at once. The plate was exposed at 7.45 p.m., and was developed at 8.5 p.m. on the same evening. The centre flash is seen to be multiple, showing six or seven discharges. The displacement of the individual flashes is due to the fact that the flash occurred whilst I was withdrawing the plate and the camera was oscillating slightly. The large flash on the left of the picture also shows a similar effect. This flash was much nearer to the camera than the two flashes near the middle of the picture; the latter are beyond a low cloud, whereas the former is in front of this cloud.

The successive strips into which the negative is divided puzzled me whilst the plate was developing, but the explanation soon suggested itself. They represent flashes which occurred during the short interval occupied in opening (and possibly also closing) the plate-holder, which were not in the field of view of the camera, but were near enough to produce a fogging effect. The time taken for the double operation of opening and closing the dark slide I found was nearly three seconds, and in this interval there were at least twelve flashes.

Another plate was exposed at 7.50 p.m. on the same evening, and as the storm was then much more distant the camera was left open for some time. On developing, three small flashes were seen to have impressed themselves (see Figure 506) and, very strangely, they were all photographically different, *i.e.*, one gave a normal image, the second a reversed image, and the third a re-reversed or solarised image.

H. E. WOOD (F.R.Met.S.).

Transvaal Observatory. Johannesburg.

MARS.

To the Editors of "KNOWLEDGE."

SIRS,—In your issue of August, there appeared a letter from M. Antoniadi with reference to a letter of mine which appeared in your June issue. In discussing the questions arising from these letters, I will endeavour as far as possible to dispense with arguments *ad hominem*, and confine myself to arguments *ad rem*.

M. Antoniadi declares that I misunderstood the purpose of his article in the May issue of your journal ("Considerations on the Physical Appearance of the Planet Mars," pages 193-196). If my interpretation of this article (which is set out in my letter in your issue of June) is incorrect, I had ample excuse for being mistaken. The scorn which in this article M. Antoniadi pours on those who are not of his way of thinking would, I think, justify anyone in supposing that he claimed that his views held the field in science. The motive which led me to criticise M. Antoniadi's article was not an anxiety to contradict, but a desire to point out to the uninitiated reader that his views are by no means universally accepted by men of science.

I am satisfied on the not very important point that there are instances where the canals have been represented out of perspective. Taking into consideration the extreme delicacy of these objects, and indeed they are so delicate as to require the most favourable conditions for observation, and even in the fine air at Flagstaff a disturbed atmosphere at times blurs them out of recognition, it is not surprising that errors of this nature occasionally occur.

M. Antoniadi seems to have altogether failed to understand my meaning when I showed (I hope satisfactorily) that it is not legitimate under any circumstances to represent as indistinct and vague an object which is seen as clear and defined. It is quite possible that if the image of Mars in the telescope could be so enlarged that with perfect definition it appeared the same size as a drawing three inches in diameter held at a distance of one foot, features which under ordinary circumstances appear sharp might appear exceedingly vague and undefined. But, on the other hand, it is also possible that they would appear as sharp and defined as they actually do under ordinary circumstances, with the possible addition of smaller canalian features. This is a question which cannot at present be decided. M. Antoniadi's analogy of a sixpence is a false one. It is true that if a sixpence (or almost any other artificial production) is greatly enlarged its details become vague. This, however, is not true of most objects of nature, in many cases the original details remaining sharp and well defined, and finer features coming into view. If a sixpence were struck of the size of three inches, all the details being perfectly defined, and then reduced to the size of an ordinary sixpence, an enlargement of it to its original size would not show the details vague. It is thus impossible to ascertain without experiment what the appearance of an object will be on enlargement. In recording observations by drawings it is therefore only legitimate to draw exactly what one sees, and it is not legitimate to make a drawing showing what one thinks the planet's appearance would be if it could be seen as large as the drawing. Such a method is drawing beyond one's vision.

Then with regard to photography. In the perception of light and shade contrast the camera is superior to the eye. Hence the great value of the camera in the perception of faint stars and strands of nebulosity and of the light and dark areas of the planet Mars. But it must be admitted that for the perception of fine, sharp detail the camera is not as efficient as the eye. Far more detail has been seen on the moon than has ever been photographed. Poor would be the observer who could see on the moon no more detail than appears on the very finest lunar photographs. In the Martian photographs all the finer detail of the planet's marking is blurred almost out of recognition. It is claimed, however, that canals are indicated even on photographs. It is noticeable that the photograph of Mars given on page 194 in your May issue shows almost as much detail as does M. Antoniadi's drawing of the same region. For light and shade studies of the planet M. Antoniadi's drawings are, undoubtedly, worthy of the highest admiration.

It is useless to go again into a discussion on the advantages of using large and small apertures. It is a matter which must depend on practical experiment. Professor Lowell, after many years' experience with a telescope of the finest make, situated as M. Antoniadi admits in the finest atmospheric conditions, appears to have found that his best results are not obtained when he is using his full aperture of twenty-four inches.

It may be interesting if I make a quotation which refers to Professor Lowell's observations from a book entitled "Is Mars habitable?" by Professor Wallace, F.R.S., who is as much opposed to the theory of the artificiality of the canals as is M. Antoniadi. He writes on page 14 of this book, in reference to one of Professor Lowell's works, "No one can read this book without admiration for the extreme perseverance in long-continued and successful observation the results of which are here recorded, and I myself accept unreservedly the whole series."

I believe that much of the dispute as to the existence or non-existence of the canals as straight lines arises from a confusion between acuteness of vision (or the perception and separation of fine detail), and sensitiveness to impression (or the perception of faint contrasts). The two qualities rarely go together in a high degree though one is often erroneously taken as a guarantee of the existence of the other.

J. E. MAXWELL.

84, DARTMOUTH ROAD, N.W.

XUM

REVIEWS.

CHEMISTRY.

Laboratory Text Book of Chemistry.—By V. S. BRYANT, M.A. Part I. 246 pages. 10-in.×7½-in.
(J. & A. Churchill. Price 4/- net.)

The method upon which this text book is based is excellent, for it aims at suggesting the use of experiment at every stage of its course. From the very first the student is encouraged to test facts and statements for himself, and the danger of his learning the theoretical part of the science by memory is guarded against by the use of supplementary questions, the answers to which will require thought. The present part includes the fundamental principles of chemistry, and the elements, ogygen, hydrogen, and nitrogen, and their chief compounds; and a further section is promised dealing in the same thorough manner with valency, oxides, carbon, and sulphur. Diagrams are provided where necessary, and blank spaces and pages are left for pencilled notes by the teacher or student.

C. A. M.

General Index to "The Chemical News."—Vols. I–C. 712 pages. 10½-in.×7¾-in.
(The Chemical News Office. Price 40/-.)

Not only subscribers to *The Chemical News*, but others who wish to consult its pages, and others again who may now be tempted to seek for information, will appreciate the issue of a general index to Volumes I to C of the periodical in question, which appeared between the years 1860 and 1909. The amount of labour entailed must have been very great. The detail which has been gone into is shown by the fact that subjects and authors are both given, while many of the former are subdivided, and cross-references have been introduced. Although the index contains two thousand one hundred and thirty-six columns, the book is of a convenient size and is only an inch and five-eighths thick. All chemists should show their appreciation of the enterprise of *The Chemical News* by adding this valuable index to their library.

W. M. W.

ENGINEERING.

Continuous Beams in Reinforced Concrete.—By BARNARD GEEN, A.M.I.C.E., M.S.E., M.C.I. 210 pages. 14 illustrations. 11¾-in.×8¾-in.
(Chapman & Hall. Price 9/- net.)

Continuity in reinforced concrete structures is at the same time one of the most advantageous features possessed by the material and one of the difficulties that has to be dealt with by the designer. In steel structures continuity of beams can to a great extent be avoided. In reinforced concrete the monolithic nature of the structure makes such an easy solution of the problem impossible. Considerable experimental work has been done on the question of continuity of structures by the French Government Commission and other bodies, but hitherto the literature of the subject has lacked a simple and reliable guide to the stresses to be expected in continuous beams.

Mr. Geen has isolated the question of their determination, and has worked out the bending moment and shear diagrams for two, three, and five spans under five different forms of loading. These diagrams have been combined, so as to give directly the maxima positive and negative shears and bending moments to be provided for in the cases dealt with.

In addition, such closely allied questions as the haunching of beams, the bending stresses in columns due to the continuity of the beams, the effect of subsidence of the supports, and some features of tests of structures are also briefly dealt with by the author.

The book is a useful contribution towards filling a decided blank in the literature of reinforced concrete. The author wisely stops at the determination of the stresses, and does not proceed to discuss the method of determining the sections necessary to resist them. That has been dealt with *ad nauseam* in the literature of the subject.

The scheme of the work is unconventional. Out of a total of two hundred and ten pages only some thirty-seven are occupied by explanatory letterpress, the remainder being devoted to diagrams and tables. The omission of the usual padding and the general clearness and conciseness of the letterpress enhance the value of the work and increase its usefulness as a reference work for practical men.

N. M.

MICROSCOPY.

The Microtomist's Vade-Mecum.—By ARTHUR BOLLES LEE. 7th edition. 526 pages. 9-in.×5¾-in.
(J. & A. Churchill. Price 15/- net.)

Since the first appearance of this book in 1885 no fewer than seven editions have been called for, and no better testimony to its value as a work of reference could be wanted. It is one which every microscopist who does any real work, as well as every biologist who makes researches, must consult again and again. That it has been once more brought up to date is matter for congratulation, and that the new edition should be in the hands of everyone interested is shown by the fact that the index alone gives more than seven hundred new entries.

W. M. W.

ZOÖLOGY.

Notes on the Natural History of Common British Animals and some of their Foreign Relations. Vertebrates.—By KATE M. HALL, F.L.S., F.Z.S. 289 pages. 64 illustrations. 7½-in.×5-in.
(Adlard & Son. Price 3/6 net.)

Miss Hall's object in writing this book is to give those who are engaged in the busy routine of elementary teaching such information as she thinks would be of great service to them in interesting boys and girls in our common British animals. We think that Miss Hall has most successfully fulfilled her purpose. To get together anything like the amount of material which is here brought into convenient compass, very much reading would have to be done, and it is quite probable, not to say practically certain, that those who lack the Author's training and experience would overlook many of the very interesting points which give the book its charm. It will appeal strongly, not only to the teachers for whom it is meant, but to all those whose tastes lead them to love natural history.

W. M. W.

NOTICES.

LIEBIG'S LABORATORY—A CORRECTION.—Figure 395, which was labelled Liebig's Laboratory, is in reality from a photograph of a Pharmaceutical Laboratory of the eighteenth century, reproduced at the Historical Medical Museum.

CHANGE OF ADDRESS.—Messrs. Wratten & Wainwright, Ltd., have removed from Croydon to Kodak House, Kingsway, W.C. A new factory has been erected for them at Wealdstone, which will enable them to enjoy all the resources of the Kodak plant.

SECOND-HAND APPARATUS.—Mr. Charles Baker's catalogue, No. 53 P, contains a classified list of second-hand photographic apparatus. This is kept separate from other second-hand instruments, of which catalogue No. 54 has just been issued, containing more than two thousand items, all of which are guaranteed to be in perfect working order.

ZOÖLOGICAL BOOKS.—The most recent of Messrs. John Wheldon & Company's catalogues contains nearly twelve hundred entries dealing with the Invertebrata, exclusive of Insects.

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